WITH EIGHT-PAGE ELECTRIC LIGHT CONVENTION SUPPLEMENT.

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World's Fair Electrical Exhibit.

PROF. J. P. BARRETT, THE HEAD OF THE DEPARTMENT FOR THE WORLD'S FAIR, RETURNS, AFTER DOING MISSIONARY WORK IN THE EAST.

Prof. John P. Barrett, chief of the department of electricity of the World's Fair, has returned to Chicago from a tour of Eastern cities.

Mr. Barrett is city electrician and superintendent of the city fire alarm telegraph. This latter distinction entitled him to a seat in a convention of fire chiefs held in Springfield, August 15. From Springfield Mr. Barrett went to Boston, and after a thorough canvass of that city in the interest of the world's fair, visited Lynn, Hartford, New Haven, New York, Philadelphia, Baltimore and a large number of outlying towns where large manufactories are established.

The result of what Mr. Barrett terms his missionary work has been very satisfactory and has filled him with enthusiasm, says the Chicago *News*.

"If one-half of the exhibits come that have been promised, we cannot accommodate them with our present space," he said. "Interest is awakening, and although it is early I find almost every establishment of electrical supplies or manufacturer of electrical machines anxious to know all the details of the building and the arrangements that have been made for the disposition of their exhibits. Some novel and startling revelations will be made. Machines now being patented, and which will revolutionize present methods, and important improvements on present appliances, will be on exhibition in 1893.

"An era in electrical science will be marked by the World's Fair, and every article in which electricity is used and every piece of machinery used in making it will be there for inspection and record. Principal among the articles in which I noticed marked improvement are standard batteries, dynamos of alternating current and constant current; cables, wires and insulators, in which Chicago's underground system has been closely copied; rheostats, switches, indicators, registering meters, ammeters and voltmeters; street, underground, mining and other railways; the arc system and fixtures; appliances for heating flat-irons, soldering-irons, etc,; electric separation of metals from ores or alloys; welding of metals and surgical apparatus.

"Especially was I pleased with the method of heating flat-irons. To witness the demonstration of a theory I have long held as practical, I visited a tailor shop where the method was in use. Not a particle of heat escaped into the room and the irons were taken from the appliance clean and hot.

"The patent commissioner in Washington has volunteered to assist me in getting models of electrical inventions, and this department will be most complete, not alone in regard to the United States, but also to foreign patents, as a move is on foot to have an exhibit of every model of this nature patented in the world. This will bring together a quaint collection, and will illustrate in the best possible manner the progress of electricity and medical and mechanical appliance of a power that we know but little of, even now.

"The electrical building is to be 700 by 350 feet, exclusive of the power house, and it is now known to be too small. The Americans alone would fill it, but as we are bound to have a full representation from all nations, they will have to be crowded a little closer together."

Mr. Barrett was asked if he would accept the commission proposed for a tour of Europe in the interest of the electricity department of the World's Fair, in connection with which his name has been prominently mentioned.

"I knew nothing of that proposition until I returned," he replied. "Of course, missionary work must be done, and if the directory think it best for me to go I shall not refuse, as I am deeply interested in the work and will do whatever is for the best interest of the Fair. Personally, I am busy and have a good deal to see to around the City Hall, but if called on, will go."

The Special Trains to Montreal.

A representative delegation of 105 ladies and gentlemen occupied the fine Electric Special train which left New York city at 9.20 o'clock Sunday morning, September 6. The train consisted of four elegant Wagner drawing-room cars, one Wagner composite car, and a dining car drawn by one of the New York Central's fast passenger engines.

The day was moderately propitious, and the trip along the banks of the beautiful Hudson River was much enjoyed. The journey was pleasantly uneventful until Manchester, Vt., was reached, when it was discovered that one side of the locomotive had broken down. The injury was carefully inspected by all the passengers, and with the practical assistance of the scientific gentlemen the engine driver was enabled to patch up his machine so that it would run pretty well on a down grade. This accident caused a delay of two hours and a half.

THE MONTREAL CONVENTION BADGE.

At Rutland, Vt., the Boston special train of three drawing-room cars was hitched on to the New York train, and the journey was resumed. When St. Johns was reached the mellow strains of the bagpipes percolated through the train, straining the air: "The Ramblers are Coming, Hurroo! Hurroo!" Presently two pipers in Highland costume walked through the cars followed by President Huntley, Mr. Corriveau, Mr. Carroll and a large party which had come down to meet the Electric Special and escort it to Montreal. The convention city was reached shortly before midnight, and the cabmen of Montreal had their hands full transferring the travelers to the Windsor Hotel.

Too much credit for the success of the trip cannot be given to Mr. Cyrus O. Baker, Jr., and Mr. A. C. Shaw, who made the arrangements for the New York and Boston trains, respectively. Mr. M. C. Roach, eastern passenger agent of the N. Y. C. & H. R. R. R., and Mr. W. R. Babcock, passenger agent of the Central Vermont Railroad, accompanied the party, and saw that their well-laid plans for the journey were brought to a successful issue. These gentlemen deserved and received the hearty thanks of the party for their efforts.

NOTES BY THE WAY.

Did you notice how few kickers there were?

T. Carpenter Smith didn't enjoy the pillow fight, and said so.

Do you remember how you enjoyed those delicious meals in the dining car? Weren't they good?

The stiff hats hanging in Car 2 seemed to attract that pillow wonderfully. There are only a few of them left.

An enterprising kodak fiend got a snap shot at some of the travelers who lifted the locomotive with a crow-bar.

Cyrus Baker's smooth manners succeeded in getting all the sweet tempered men to buy the poor seats. "Give me a seat on the river side in Car 2," was what those who knew asked for.

Senator Royce was unfortunate in purchasing a ticket that had been called in. Through the intervention of his friends the conductor was persuaded not to stop the train at Sing Sing and escort the Senator to the large hotel there.

Who was the man that brought that pillow into Car No. 2? He deserved to have his hat smashed, and it probably was. The fun was fast and furious for a time and the man who didn't get a lick himself and one at some other fellow missed it.

American Institute of Electrical Engineers.

The Fifty-ninth meeting of the Institute, and the first of the present season, will be held at 12 West Thirty-first street, on Tuesday evening, September 22, at eight o'clock. A paper will be presented by Prof. Harris J. Ryan, of Cornell University, "On the Relation of the Air Gap and the Shape of the Poles to the Performance of Dynamo Electric Machinery." Members who are especially interested in the subject may secure advance copies upon application to the secretary. The council will meet in the secretary's office at five P. M.

The American Street Railway Association.

It is announced that the rate of a fare and one-third has been allowed to delegates and all others, including members of their families, in attendance at the tenth annual meeting of this association, which will be held in the city of Pittsburgh, Pa., October 21–23, 1891, by the following associations, namely: Boston Lines Passenger, Central Traffic, New York and New England Passenger, Southern Passenger and Trunk Line; also on the Chicago and Alton Railroad from all points in the State of Illinois. Michigan is excepted from the Central Traffic Association. This covers nearly all the territory of the United States, with the exception of that controlled by the Western Passenger Association.

A large atttendance at this convention is assured.

THE FOURTEENTH ELECTRIC LIGHT CONVENTION.

SUCCESSFUL MEETING AT MONTREAL LAST WEEK.

The Great International Electrical Exhibition—An Immense Attendance—Social Events—Hospitality of the Montrealers.

BUFFALO, N. Y., SELECTED FOR THE NEXT MEETING PLACE—A FULL REPORT OF WHAT WAS SAID AND DONE.

The account following will give those central station men who were too busy to get away, some idea of the most successful and most largely attended convention ever held by the National Electric Light Association. The proceedings were of the most interesting character, the exhibition was a success in every way, the social features were delightful, and Montreal will always be a pleasant recollection to the electrical visitors.

A careful perusal of the following report will be of interest to every one, whether an attendant or a compulsory stay-at-home.

First Session—Monday, September 7.

The National Electric Light Association began its Fourteenth Convention at the Windsor Hotel, Montreal, September 7, 1891. The president, Mr. Charles R. Huntley, of Buffalo, N. Y., took the chair at three o'clock P. M. The large hall was well filled with ladies and gentlemen, and many distinguished Canadians were seated on the platform, including Sir Donald A. Smith, Sir William Dawson, Mayor McShane, Prof. H. T. Bovey, Erastus Wiman, Judge Armstrong and the vice-presidents of the Association, Mr. J. I. Ayer and Mr. M. J. Francisco.

President Huntley: It affords me great pleasure, in opening this, the fourteenth convention of the National Electric Light Association, to have the honor of presenting to you the chairman of the citizens' executive committee of the city of Montreal, Professor Bovey, of McGill University.

Professor Bovey: It devolves upon me, as president of the citizens' executive committee, to offer you a very hearty welcome. It is no little pleasure to have this opportunity of meeting and making the acquaintance of so many of the foremost promoters of electrical science. We sincerely hope that this convention will be full both of instruction and enjoyment. We feel sure of the instruction, as that depends upon you; as to the enjoyment, we trust that the entertainment provided in the programme will prove agreeable diversions. Gentlemen, I again wish you a hearty welcome. I have now the honor of calling upon His Worship, the Mayor of Montreal, the Honorable James McShane, who will address you. (Applause.)

Mayor McShane: When my friend, Mr. Bovey, who just sat down, said that he

would introduce me to the audience, and that I would make an address, I think he made a misstatement. I am here as the Mayor of Montreal, and I have but a few words to say to you. Some few months ago Mr. Corriveau, a native of the city of Montreal, a French Canadian, called upon me one day at the City Hall and asked me, as Mayor of the city, if I would, in my own way, endeavor to give him some encouragement to ask your body to make Montreal your next place of meeting. At that time I gave him a letter, and I believe that Mr. Corriveau has nobly done his part. I know that there was opposition, and I think that St. Louis and other places in the United States had sought to take you there, but Montreal has succeeded in bringing you here, and now, in the name of the citizens of Montreal, I offer you a hearty and sincere welcome. (Applause.) I am sure that the citizens of Montreal will do what they can to make your stay while here as pleasant and agreeable as possible. I am not going to speak of the great good that your Association has done and will do in the future, because there are some gentlemen upon this platform—gentlemen who are a credit to any country from which they may come—who will speak to you upon that subject. But I can assure that if I understood all the facts, I might make an humble effort to say something to you upon the question, but I would sink into insignificance when you hear the gentlemen who are to come after me, and who will speak to you upon the great subject which you are here to consider. Therefore, I will just content myself by saying to you again that you are most welcome amongst us, and that the people of the city of Montreal will do all that they can to make your stay with us as agreeable as possible. (Applause.)

Professor Bovey: I now call upon Sir Donald A. Smith to say a few words.

Sir Donald A. Smith: Mr. President, officers and members of the National Electric Light Association, ladies and gentlemen. You have already heard words of welcome from the president of the Citizens' Association, and also from His Worship, the Mayor of Montreal, spoken in more appropriate terms than it would be possible for me to use. My own words are not required to give you a hearty welcome, but I do assure you, for my fellow citizens and for myself, that we are delighted to have you with us, and that it gives us the greatest satisfaction to find that you have honored us by coming here on this occasion. I do assure you that we appreciate very highly having you amongst us. Nothing can be of more benefit, nothing can tend more to induce cordiality amongst the peoples of one nation and another than such conventions, such comings together, such communings as we are to have here on this occasion. We hear occasionally of such things as a union, and there may be different views as to whether it may be beneficial or otherwise. I have no doubt there are such in the United States, and also in this country. But, be that as it may, I am one of those who believe that a coming together, as on this occasion, of the peoples of different countries, and especially those who are neighbors, as we are, and have such constant and such great relations with each other in trade and in every respect, cannot but clear away many of those cobwebs and many of those ideas which we have had each of the other, and which were entirely erroneous. (Applause.) And I am sure that the welcome which you will have here from the people of Montreal will be as sincere, as earnest and as cordial, as it would be possible that any welcome could be. As we shall have the pleasure of meeting again this evening, I believe, amongst others, I may then be with you, and see the great advance that has been made in this science of electricity, to see how by the power of man it can be controlled, and that although when left to itself it is capable of doing injury such as we cannot calculate, yet when under proper restrictions it is capable of almost turning the world upside down in every thing that is for the benefit of mankind, even so should we in welcoming such gentlemen as you, Mr. President, and those who have come here, not only to interest, but to instruct us; and I will only again, before s tting down, say that you have a most cordial welcome from the citizens of Montreal, and that we only wish to know how we can make pleasant to you in the best way in our power your visit amongst us on this occasion. (Applause.) But before sitting down I would say that we have had communications from His Excellency, the Governor General of the Dominion, Lord Stanley, which express very great regret at being unable to be here to join in doing honor to you to-day, on this occasion and this evening, but he has made a point of arranging his engagements so that we shall hope for his presence at the banquet which our citizens will have the honor of tending to you on Thursday. (Applause.)

Professor Bovey: I have now the great pleasure of calling on Sir William Dawson, the Principal of the McGill University. (Applause.)

Sir William Dawson: Mr. President, ladies and gentlemen of this Association: In tendering you a cordial welcome, not only from McGill University, but, I think, I may say, also, from all teaching bodies in the Dominion of Canada that are interested in the practical and applied sciences, I only recognize what now all of our universities and colleges are bound to recognize—that in the presence of an Association like this we are in the presence of the representatives of a great, growing and coming profession, and one which more than perhaps any other has served to bring to the notice of the world the great advantages that may arise from the prosecution of the physical sciences. Your science was prosecuted for a long time before much was known of its practical applications, but in the present day, as you know, and in the last few years, this great subject of practical and applied electricity has not only come to be something wonderful in the growth which it has presented with regard to its own special developments in telegraphy, in lighting, and in other matters of that kind, but also because it has been, young though it is, lending a hand to older scientific professions. We find now that the civil engineer, the mechanical engineer, the mining engineer, the metallurgist and the assayist, all of them, are under obligations to the electrical engineer, and it is now extending its hand—this young giant which has grown up amongst us—to all the older branches of our scientific professions, and it is making more than ever before the subject of the physical sciences one which is attracting the attention of the community, and young men are endeavoring more and more to qualify themselves to enter professions of this kind. That gives us in our university a good reason, and gives all universities everywhere a good reason for recognizing such an Association as this by offering it a cordial welcome, —and which we in McGill University are entitled to do, the more especially on this occasion, because you honor our academical town with your presence. That we consider to be a great honor, and not only so, but you come at a time when we in McGill University are expecting, at the next session, through the liberality of one of our great benefactors here in Montreal, to be able to establish for the first time in a thorough and efficient manner, a course of electrical engineering (applause), and in which we hope to have many of our young Canadians emulate the skill and success which you gentlemen and others on the other side of the line have so eminently shown in this great and rising profession. And so, on behalf of McGill University, and I may say in behalf of all educational interests in Canada, I have the greatest pleasure in offering you a kindly welcome, and in saying that we shall do all that we possibly can to make your stay here as pleasant and as profitable as possible. (Applause.)

Alderman Clendinning, Mr. Justice Wurtele, Ex-Mayor Beaugrand, Alderman Cunningham and Mr. Richard White, also spoke briefly extending a hearty welcome to the visitors.

President Huntley: For the first time in its history, the National Electric Light Association meets on other than its native soil. Yet even in so doing it but adds new evidence to the feeling in the breast of every electrician, that his art is foremost among the influences tending to promote human intercourse and break down the walls of separation. Coming, as do our members, from every state in the Union and the Dominion of Canada, and representative as they are of all the varied agencies and methods for the distribution of electric light and power, it affords me the greatest pleasure to acknowledge in their name the fraternal welcome with which we have all been received, and the lavish hospitality that makes us at home in this noble Dominion and in its magnificent city of Montreal. (Applause.) From the fact that the invitation was so cordial, and that the reception has been so warm, I can but infer that the Association enjoys here an intelligent appreciation of its work, its objects and its aims. Permit me to say, therefore, that the Association asks for itself, during the coming week, a kindly tolerance of its technical papers and discussions, hoping that the large exhibit of electrical apparatus of the latest and most perfected character may make amends for the somewhat abstruse nature of its proceedings. If the earnest and practical quality of our dealing with the great questions of electricity shall in any wise stimulate electrical work in Canada and lead to the electrical utilization of its great water powers and coal beds in light, locomotion, power and heating, we trust it will be accepted as at least some slight acknowledgment of the manner in which we have been so generously greeted. (Applause.)

I have the honor of calling upon United States Consul General Knapp to say a few words to us in behalf of the United States.

Mr. Knapp: It affords me great pleasure to be present and participate in the exercises of this afternoon, and I am sure that you need no words from me, after those which have been uttered by the several gentlemen who reside in the city of Montreal, to assure you of a most hearty welcome, and I am certain that I can speak for the members of the Electric Light Association, in saying that should it ever be the lot of citizens of Montreal to visit their cities, that they will give you a loyal and elegant greeting. But I assume that it is with the gentlemen who have spoken from the city of Montreal, as it is with me, one of the best thoughts connected with your coming here, that you have come in a most gallant way, that you have brought with you those we all like to see—the ladies—and so I will say, for the city of Montreal and her citizens, that we bid also a loyal and royal welcome to the ladies who come with this National Electric Light Association. The associations of this hour are suggestive of twofold congratulation first, congratulation to the city of Montreal, that she has the privilege of having so royal a guest and one so worthy of her hospitality as this National Electric Light Association, an Association which, although young in years, embraces in its membership men who have become famed in their works, men whose success in the great fields of science and invention have become the proud heritage of mankind, an association which has for its purpose the development of one of the grandest sciences known in this nineteenth century, a science which in its development and in its application is for our good, ministering to the wants of humanity and also ministering to the wants of nations. But while I congratulate the citizens of Montreal in having so royal a guest, I may also congratulate you who come from the United States in having a host so royal as is the city of Montreal. Let me say to you, as visitors of my own nationality, you will realize that it is a city justly famed, a city where mercantile and manufacturing industries tell the story of prosperity; a city made beautiful and interesting by historic spots, by noble monuments, by stately edifices, where churches of every denomination point toward heaven their spires of faith, and where institutions of learning, like the McGill College, rise like exhalations and shed their rays of light through this Dominion to other nations and to the world. You will also find it a city whose citizens always have a hand of welcome, a word of greeting and a heart of friendship, for the representatives and for the people of the United States. And so I say that this is an hour for mutual congratulations and felicitation, and as I join in them and in one sense bid you welcome, in another sense, if I may be permitted, I will express to the citizens of Montreal your gratitude for this royal greeting, and I beg to express the hope that as your stay will be pleasant, so your convention will be one of profit to you as individuals and of advantage to the great science you represent, and through it all we shall realize better than ever before that we are all citizens of two countries which are and will continue to be royal friends. (Applause.)

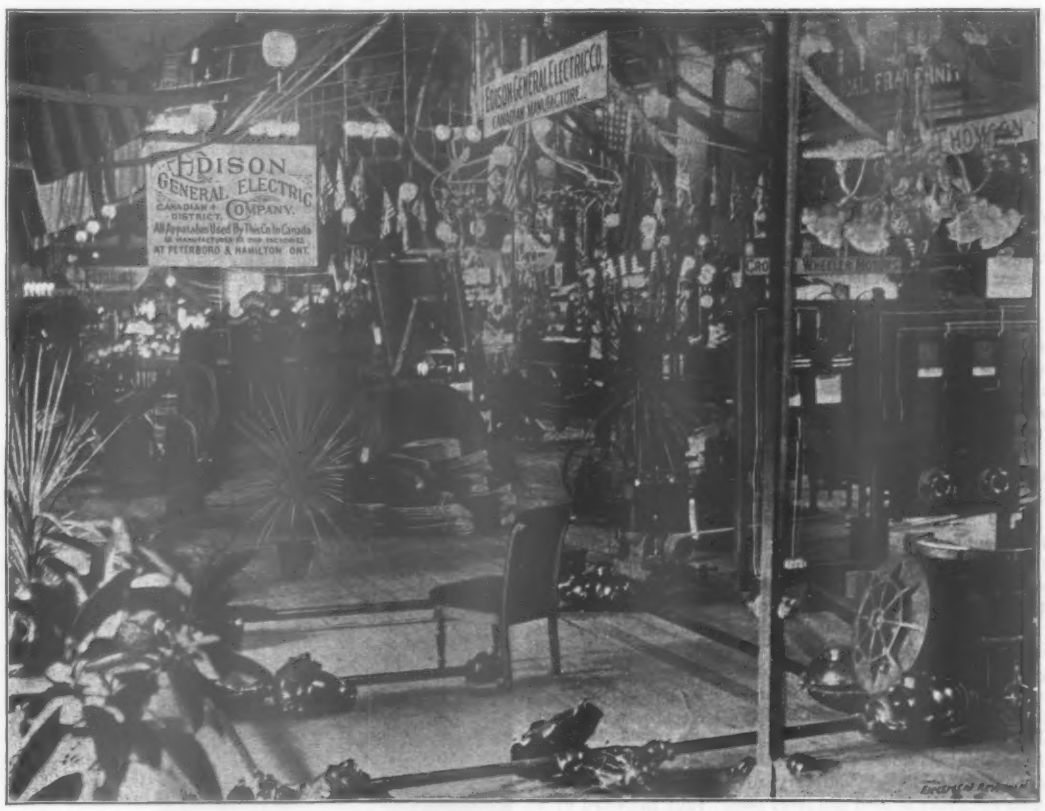


FIG. 1.—VIEW OF PART OF THE EDISON GENERAL ELECTRIC COMPANY'S EXHIBIT AT THE MONTREAL ELECTRICAL EXPOSITION.

The President: I have now the honor of introducing Judge Armstrong, of Camden, N. J.

JUDGE ARMSTRONG'S RESPONSE.

Judge Armstrong: As I have listened to these cordial words that came to us I realized again, and more fully, I think, than ever before, what electricity does. It has been called the great annihilator of space—that thing that reaches its destination as soon as it starts. It is evidenced here to-day that it can annihilate State lines; that with it no peoples are known—only one people; and no communities are known—only one great family. We, therefore, appreciate most heartily the welcome you have given. You have asked why we should leave the cities of the States, where we peculiarly belong, it is claimed, and come here. Do you know who your representatives were that you sent down to invite us to come? If you do know them as we have learned to know them you will know that we could not help coming (applause). They promised us well, but we have already received much more

than they ventured to promise. Had they told us what you have told us here to-day, we would have begun to suspect that their promises were too fair—the allurements were too great—and we would have been afraid to come. They just told us enough to induce us to come, and we are glad that we came. I would not dare, I suppose, across the line—I have heard you refer to some line here—I would not dare, I suppose, across the line to refer to the thing that Sir Donald Smith referred to, but I imagine I can venture to do it here, because I have understood since I have been here that there are no politics whatever in the Dominion (laughter). The McKinley tariff bill was referred to, and I heard a great many ladies complaining when they were crossing that line, and I would like to say to them that the examination was not on account of the McKinley tariff. I find that while Montreal is all that has been claimed for it, I stood at that point and overlooked as fine a scene as ever my eyes beheld. It was, indeed, a royal view. Spread out before me was a scene of marvelous beauty. We saw the magnificent buildings, the great churches, the industrial establishments. We saw here and there the evidence of stupendous enterprise, and we learned that this was, indeed, a city of great progress and a place of great enterprise. But I was greatly surprised to find that you had not learned one thing over here as well as we could teach you across the line. I heard your ex-Mayor say, in speaking for the French Canadians, that 150,000 was a majority of 250,000. Now, we can find many ward politicians down our way that can show you how that majority can easily be overcome (applause). We do not count majorities in that line at all, and I am surprised, with all your enterprise, with all your advancements, that that is one thing that you have not grown on Canadian soil yet.

This welcome, though, my friends, that we have received, it seemed to me, as I saw the earnest expressions on the faces and as I knew, as men can know, that these words came from the heart, I looked down here at this badge and I saw the two flags, distinct and separate, standing out clear, but under the button bearing our name, there was some sort of connection; it was completed there. The flags stand distinct, sure—sovereignty's representatives of distinct States, and yet they meet at a common center; they meet at a common point; they have a point of contact where they are all interested.

And glad am I to meet in such an assembly; glad am I to take part in such a community. When such assemblies gather, when such communities meet, when such interests are brought together, then you may know that all the dickering of politicians, that all the selfish enterprise of sovereigns or sovereignties, that everything that may be done by individual ambition or individual avarice must give way to that thing that speaks so well for common humanity—that one enterprising feeling, that one desire, that one earnest hope to benefit the whole of the people of the world and advance them all as one community. I, therefore, particularly appreciate the welcome, the Canadian welcome, that is given to this Association. I particularly appreciate the fact that we are here assembled, and while I never mean to forget, nor do you want me to forget, that my allegiance is owned somewhere else, I am proud that upon this great continent there is a people of such enterprise, such energy and such ambition, as I have been permitted to see in the few hours that I have been here. I rejoice with you, my friends upon this committee, on the promising future that you see for Canada. I rejoice because what does you good will do us good, what is good for us will be good for you, and what is good for you will be good for us. Our community of interest is great. I am glad that we can meet here with you and I feel, in the language of the German doctor whom I have heard speak at one of the International medical conventions—he was speaking, and he desired to express how he enjoyed being there. Seeing his own flag from his window, he said it made him feel very homely, and the words that I have received from you here and what I have seen floating over the hotel where we stop—the banner of our own country, seeing it over McGill College—seeing all these things has made me feel very homely, and when one of your Aldermen came out and, after joining in the welcome, began to apologize for your streets, I felt entirely at home. (Laughter.) We have been greatly libeled as a people, and will you permit me to make this inquiry? It is said that, as Americans, we want everything, and I am inclined to think that some of this committee may have had that same notion in mind when they came and extended this welcome, because they did not propose to leave anything to be asked for—they have given us the whole thing, and I only question in my mind whether or not it was because of that libel upon us as a people. I trust that that may not be so.

Now, one word more. One of the speakers congratulated us because we brought the ladies along with us. That proves conclusively that he has not been at our electrical conventions heretofore, and I am sorry to say that it proves that he does not know anything about the science of electricity. Ask any one of these bright, young electrical engineers—and you will observe that most of these electrical engineers are young men—ask any of these engineers what he could do without an attachment. Ask him to tell you how necessary it is to have both positive and negative currents, and ask him, also, about the essential character of a switch. (Laughter.)

I speak not merely formally when I say to your Worship, to the chairman of this committee, to this committee, and through them to the citizens of Montreal—I speak not merely formal words when I say that in our hearts we deeply appreciate this welcome. A more cordial welcome this Association has never received; a more hearty reception has never been given; and this coming to this place at this time and under these circumstances, we deeply appreciate it. We have gone about your beautiful city, and I want to say right here, that I went to ten churches yesterday, and I understand I have got 66 yet to visit. As we go about your beautiful city and see the good that you have here, and see the enterprise that you have here and see the works of beneficence and benevolence that have been inaugurated here—as we see all these things and receive such warm words, such hearty greetings as you have brought to us, we promise you that in so far as in us lies, we shall make this convention the banner convention in the history of the National Electric Light Association.

The President: I have the pleasure of introducing to you Mr. Erastus Wiman, of Staten Island, New York.

Mr. Wiman: I could not resist the temptation to spend a few hours in Montreal, to act in a double capacity. A resident and a member of this Association in New York, I wanted to come here and partake of the hospitality of the city in which I spent some of the happiest years of my life and in which, perhaps, I am better known than any man that ever left it. In another capacity I want to come as a Canadian and to say a few words of welcome to the men with whom I have been associated in the latter years of my life in the great country on the South—to say how glad we Canadians are to see you among us. There is nothing in the world that is so productive of good as the mingling of these two races together. If they met more often, if they understood each other better, if they comprehended the great good that is in both, better conditions would prevail and a larger charity and a better trade and a greater progress would come in everything. But I come to-day in this double capacity simply to testify, as I think no other Canadian can testify, to the Canadians themselves what a marvelous brood of young fellows has sprung up in the last five years in connection with electrical engineering and electrical propulsion. It seems to me as if a new creation had dawned on the world. I want to say to my young Canadian friends what a beautiful thing it is to think that out of the great cities like Chicago, St. Louis, Boston, Providence, New York and all over, there should come such a representative group as we have here to-day, so representative of the great growth of science—such wonderful achievements as they have been the instrumentalities of performing. I am glad to stand be-

(Continued on page 42.)

FIG. 2.—PART OF THE EXHIBIT OF THE THOMSON-HOUSTON INTERNATIONAL ELECTRIC COMPANY, AT THE MONTREAL ELECTRICAL EXHIBITION.

Middlesboro, Ky.—Automatic Electric Scale Company; capital, $100,000.

Jersey City, N. J.—The Fibrone Company; capital, $70,000; manufacturing fibrone and plasticon.

Baltimore, Md.—Roland Avenue Electric Railway Company; capital, $25,000; operating passenger railway.

Baltimore, Md.—Lehmann Manufacturing Company; capital, $10,000; manufacturing pneumatic and electrical supplies, etc.

Portland, Me.—Jenney-Star Electrix Company; capital, $30,000; manufacturing and dealing in electric motors, dynamos, lamps, etc.

Cœur d'Alene City, Idaho.—Cœur d'Alene City Illuminating Company; capital, $20,000; supplying electric light in Kootenai County.

Red Oak, Iowa.—The Red Oak Electric Company; capital, $20,000; constructing and operating electric plants for supplying light, etc.

Philadelphia, Pa.—The Wright and Star Electric Company; capital, $250,000; manufacturing and dealing in electrical appliances and machinery.

Astoria, Ore.—Holladay Park Improvement Company; capital, $5,000; grading streets and highways; constructing and operating electric railways, etc.

Beaver, Pa.—The People's Electric Street Railway Company; capital, $50,000; constructing and operating street railway from Bridgewater to Economy Township.

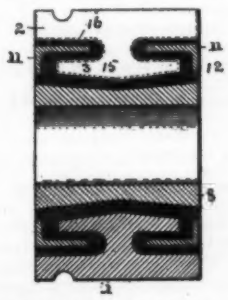
Circleville, Ohio.—The Circleville Light and Power Company; capital, $100,000; manufacturing gas, coal tar, coke, ammoniacal liquor, ice, etc., producing electricity.

Oakland, Cal.—Piedmont Spring Water and Power Company; capital, $1,000,000; operating water works; constructing and operating machinery for generating electricity, etc.

Chicago, Ill.—The West and South Towns Horse Railway Company; capital, $100,000; constructing and operating horse, electric, cable or dummy railroad from Lawndale to Lake Michigan.

Improvement in Commutators.

With a view of avoiding the loosening of commutator segments, Robert Lundell, of New York, has devised the commutator illustrated in the accompanying engraving. The several collecting blocks, 2, are stamped or cast of substantially an H-shape and assembled with interposed strips of mica or insulating material, these separating strips being larger than the commutator blocks, as indicated in the engraving, the dotted outlines indicating the commutator block, the full line the insulating medium. The blocks are assembled and a double cone sleeve, 8, inserted, the spaces between the sleeve and the segments being filled with insulating cement or other compound which will harden. Strengthening rings, 11, of metal are forced into the cement while still plastic



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Didn't you hate to leave Montreal?

The synonym for hospitality is—Montreal.

One peculiar feature of Montreal is its lack of street railways. This is probably owing to the heavy grades of some of the streets. The cab service, however, is excellent.

We desire to direct especial attention to Messrs. Roach and Babcock, passenger agents, C. O. Baker, Jr., and A. C. Shaw, for the excellent railroad facilities they obtained for the New York and Boston delegations. The trip was a great success, all enjoyed it, and we hereby express the sentiments of everybody on the two trains when we offer unofficial thanks to the gentlemen named.

It was the greatest convention.

If you didn't go to Montreal, electric light man, you missed that which will probably never be your privilege again.

Any visitor to the United States from Montreal has only to make himself known in electrical circles to be received with open arms hereafter.

In the *Electrical Engineer* of September 9, Mr. R. O. Heinrich describes a multiphasal system of transmission of power, the same being a type of rotary current transmission, and styles it the "Schuckert multiphasal system." It would be interesting to know how the system described and illustrated in Mr. Heinrich's article comes to be known as the Schuckert system, as it is identically the same as the system of Charles S. Bradley, upon which United States patent No. 390,439 was issued October 2, 1888, Figs. 10 and 11, used in illustrating the alleged Schuckert apparatus, being *fac-simile* reproductions of Figs. 3 and 5 of Mr. Bradley's patent.

The National Electric Light Association has never had a more loyal and hard-working president than Chas. R. Huntley, of Buffalo. It was his energy and judgment and untiring zeal that resulted in making the Montreal meeting the pronounced success it was. And in giving praise where praise is due, mention should be made of the unceasing efforts and valuable assistance given, in season and out of season, by Mr. John A. Seely, of New York, who is, we think, the hardest-working member the executive committee ever possessed. There are many others who deserve much credit, but space will not permit more extended mention, and all who labored in behalf of the Montreal meeting may congratulate themselves on work well done, and on distinct and valuable advances made in the science and industry of electricity.

An organization called the New York Tax Reform Association, of which Gen. C. T. Christensen is president, Bolton Hall, secretary, and John Claflin, treasurer, is ventilating the subject of tax reform, with a view of effecting legislation on this subject. Efforts will be made to exempt mortgages and capital engaged in production or trade from taxation, because it is stated such taxes tend to drive capital away and put a premium on dishonesty and discourage industry. It is not within the scope of this journal's work to open a discussion on a question of such a general character as this, and one which involves unsettled questions of political economy. The lay press can safely be left to probe the matter to its core and influence the public pulse. There are many who think that taxes should be apportioned in correspondence with ability to pay, and that the millionaire whose estate lies in bonds and stocks should contribute his quota to the expenses of government as well as the mechanic who husbands his small earnings to meet the taxes on his humble cottage, or the farmer whose narrow margin of profit is shaved closer by the taxes on his land. The same government lends stability and security to the possessions of all. It is natural that the small holder should urge that the value of his property, whether it be buried behind locked doors or exposed to the light of day, should be the measure of his contribution to the support of the State. To this class it will not appear clear that real estate "should bear the main burden of taxation."

BUFFALO NEXT.

At the executive session of the National Electric Light Association, at Montreal, it was decided to hold the fifteenth convention in February, at Buffalo, N. Y. This is the place where President Charles R. Huntley lives, and it may be depended upon that he will be hand and heart with any scheme to make the next meeting a success. If all the Buffalonians are as energetic, well-informed, hospitable, and progressive as President Huntley, we shall be well cared for.

THE MONTREAL CONVENTION.

A full and interesting account of the proceedings of the Fourteenth Convention of the National Electric Light Association, held at Montreal last week, will be found in this issue of the ELECTRICAL REVIEW. We also present a number of handsome illustrations, showing several of the exhibits at the electrical exposition held in the Victoria Skating Rink.

Considered from any standpoint, this convention was a signal and unqualified success. And what was most encouraging was the distinct central station flavor which pervaded the convention proceedings. This was eminently gratifying and proper. The papers were ably written and actively discussed; the electrical exposition was the best ever attempted by the Association; the social functions were of an unusually refined character, and the excursions to places of interest were well selected and carried out.

The most prominent subject of remark was the royal hospitality of the citizens of Montreal. Never in the history of the Association have the delegates to a convention been so elegantly entertained.

We think that every one who attended this meeting is glad he went and better for it.

JUMPING OVER THE TRACES.

One of the bits of general information which are being brought to the unprofessional mind by the widespread practical uses of electricity is that a covering on wire is not necessarily an insulator, trade-marks to the contrary notwithstanding; and that materials other than copper wire may be conductors.

An instance in hand recently occurred in a public building in Boston, during the recent spell or spell and a half of rainy weather. A man sitting in a draughting room with his head against a German silver triangle which was hanging from a nail on the wall, touched a drop-light on a table, and received such a severe shock that it is said he cannot tell a straight story about it to this day. The story has grown so on his hands that it is expected that he will soon allege that the incident was a fatality. An investigation, however, revealed the facts in the case to be that the electric lighting wires entered the building above a window of the room in question, and the frame of a window awning when closed pressed against the wires, which were covered with cotton braid. The room had been painted with a metallic composition sufficient to render it a fair conductor, which condition was increased by the humidity of the atmosphere. The rubber tube to the drop light contained a spiral spring to keep it from collapsing, and in this manner established a line of electrical conductivity from the stand of the drop-light to the gas-pipes. A slight escape on the electric circuit outside the building furnished the rest of the evidence necessary to account for the first statement of fact as to the shock.

Another instance of electrical phenomena obtruding itself on an individual occurred in an office building in Boston, when a tall man standing near a chandelier was startled, with a ruffled dignity, by a tingling at his ear-tip, and a stream of sparks established a direct line of communication between the ear and chandelier aforesaid. This static electricity was probably due to the belt of the engine driving the elevator, generating static electricity which charged all the gas pipes in the building.

Electricity from belts is frequently surmised to be a cause of fires, although like much other circumstantial evidence, "no one saw him do it." Flame was seen issuing from a gas pipe near a belt in a machine shop. The belt was overloaded, and would at times run to one side, chafing against a gas pipe until it wore a hole in the pipe, and then the static electricity from the belt lighted the gas, and the flame was discovered before any further damage occurred.

Electricity from belts is a source of serious annoyance in textile manufacturing. The "young man" came to the shop from school loaded with little enough learning to make him dangerous, and boldly undertook to solve this problem by conducting wires from the main belts to the casks of water put around the works to please the insurance people. If he had done what he thought he did he would have learned that grounding the wires would not make any practical difference in such cases.

ENTERTAINMENT AT MONTREAL.

The City of Montreal will ever be remembered by the electrical visitors for the large-hearted hospitality of its citizens. Outside of convention hours the visitors, particularly those who had brought their wives, were entertained with garden parties, dinner parties, receptions and drives. The complete programme, in respect to entertainments, was not only carried out as before announced, but was added to and several additional receptions and dinner parties were given. Prof. Henry T. Bovey and his charming wife made life-long friends of all who met them, and the delightful garden parties given by Mrs. Molson and Mrs. Redpath on their beautiful lawns were particularly enjoyed by the visitors from the United States, who here met with some English touches of a social nature as pretty as they were novel. The reception at McGill University, Tuesday night, was an event of special note and importance, and was most largely attended. At this reception, and, in fact, at all of them, delicious refreshments were served.

In addition to the private dinner given by Sir Donald A. Smith, a reception was held at his magnificent home in honor of the Governor-General, Lord Stanley, Thursday afternoon, from 4 to 6.30. Several ladies and gentlemen who were detained by the excursion down the Lachine Rapids, although late at this reception, were most courteously received by Sir Donald and Lord Stanley, the former personally showing them through his beautiful gallery of valuable paintings and room of rare Japanese ware, and serving refreshments afterwards.

The trip down the Rapids, the firemen's drill, the water pressure exhibit, the most attractive drive over the city and around the mountains, were all highly enjoyed and the electrical visitors will carry many pleasant memories of those events away with them.

THE BANQUET.

A banquet was tendered to the visitors by the citizens of Montreal and nearly 400 gentlemen participated, Sir Donald A. Smith presiding, with Lord Stanley and President Huntley on his right and left. Before entering the banquet room, the Governor-General and Sir Donald held an informal reception in the ELECTRICAL REVIEW parlor and were introduced by Professor Bovey to many of the electrical visitors.

The banquet was highly enjoyed, a number of good speeches being delivered, speaking of the most kindly feeling that existed between the two countries. On behalf of the Association, Mr. T. C. Martin presented a phonograph to Professor Bovey, and President Huntley was overwhelmed with the gift of a very elegant ebony mallet with gold mountings, his name appearing on it in beautiful letters. Professor Bovey made the presentation speech.

Toasts were responded to by Lord Stanley, President Huntley, United States Consul Knapp, Sir Wm. Dawson, Mayor McShane, Geo. M. Phelps, Thos. D. Lockwood, J. Carroll, Gen. C. H. Barney, A. J. Corriveau, and others.

SIR DONALD A. SMITH'S DINNER.

A very delightful dinner was given by Sir Donald Smith, Wednesday evening, September 9. About 40 guests were invited to his beautiful home, among the gentlemen being: President C. R. Huntley, John A. Seely, Cyrus O. Baker, Jr., John W. Beane, Gen. C. H. Barney, S. Insull, Capt. Eugene Griffin, Lieut. S. Dana Greene, Chas. W. Price, T. C. Martin, Geo. W. Davenport, Jas. I. Ayer, Judge Armstrong.

NOTES.

The handsome convention badge was all-powerful with the hospitable Montrealers. Any one wearing it received the most polite treatment imaginable. It passed many of the visitors into places of interest where strangers were not usually allowed.

To Mr. John Carroll, secretary of the committee at Montreal, the largest part of the detail work of entertainment fell, and his genial nature never failed him. He was as ubiquitous and zealous as it was possible to be and made everybody happy who met him.

Col. Stevenson, the Chairman of the Fire Committee of the Montreal Council, was untiring in his efforts to have the visitors enjoy themselves. The ladies, particularly, were favored by the gallant Colonel, and many of them were presented with beautiful hand bouquets, with his compliments.

The firemen's parade was a most imposing spectacle. The fine horses and manly appearance of the firemen were greatly admired. One fire engine company displayed a large American flag on the top of their engine. They were greeted with cheers and salvos of hand clapping whenever they passed the reviewing stand.

Mr. Louis Lesage, Secretary of Canals for the Province of Quebec, was especially good to the American visitors, devoting a large part of his valuable time to escorting them to the various points of interest in and about the city. Mr. Lesage renewed a number of acquaintances which he made when on a visit to the Electric Club, of New York, last spring.

The privileges of the fine old St. James' Club, of Montreal, were extended to a favored few. Among those who were put up were Messrs. Samuel Insull, Chas. D. Shain and Luther Stieringer, of the Edison General Electric Company; Mr. H. L. Shippy and Dr. F. A. C. Perrine, of the John A. Roebling's Sons Company; and Mr. Stephen L. Coles, of the ELECTRICAL REVIEW.

Members of the St. James', Metropolitan, Canadian and City clubs very kindly extended the privileges of their handsome club houses to a number of the visiting delegates. These four are the principal clubs of Montreal, the St. James' having been founded in 1857. The Canadian Club, as its name indicates, is composed solely of Canadian gentlemen. The entertainment at all the clubs was of the most hospitable character.

GROUP OF MONTREAL EXHIBITION VISITORS.—PRESIDENT HUNTLEY AND LORD STANLEY SEATED IN THE CENTER, SIR DONALD A. SMITH AND MR. EUGENE F. PHILLIPS STANDING IMMEDIATELY BACK OF THEM.

OUR ILLUSTRATIONS.

The ELECTRICAL REVIEW takes pleasure in presenting in this issue a number of photographic views of several of the exhibits made at the Montreal Convention. The visitors who see this paper will at once recognize the excellence of the portraiture.

The group picture, which was taken in the center of the exhibition hall, the gentlemen being seated or standing in the exhibition room occupied by the Eugene F. Phillips Electrical Works, is composed of a number of distinguished gentlemen. Those seated are, beginning at the left, Prof. H. T. Bovey, President Charles R. Huntley, Lord Stanley of Preston (governor general of the Dominion of Canada), and Mr. James I. Gulick, chairman of the exhibition committee. Sir Donald Smith stands back of Mr. Huntley. The others in the group will be readily recognized. We are particularly pleased to be able to present to our readers the portraits of Sir Donald and Lord Stanley. Both of these gentlemen took a great interest in the exhibition and in the visit of so many gentlemen interested in scientific and industrial matters from the United States. Sir Donald in particular exerted himself at all times to make the occasion a complete success socially, throwing open his beautiful mansion to the visitors, giving a reception to all, and a private dinner to a number of the leading electrical representatives.

THE ELECTRICAL POWER TEST AT FRANKFORT.

Information relating to the rotary current motors by Mr. Dobrowolsky will be read with special interest in view of the reported success of transmission of power from Neckar Falls to Frankfort, a distance of 108 miles, by this system. If the tests prove what is claimed, that the efficiency of this type of motor is as high as 80 per cent., a tremendous acceleration will be given to alternating current business. Although three wires are used, but 40 per cent. more copper is required than would be necessary to carry a single current of the same amperage. The controversy being waged by our contemporaries as to priority of invention in this type of motor between Mr. Tesla and Prof. Ferraris is of less importance than the question of priority between Mr. Bradley and the European inventors of the three-phase system. Mr. Dobrowolsky showed very clearly the weak point of the quarter-phase system of Tesla and Ferraris—the surging up and down in strength of the magnetism, as it sweeps around the ring, develops a high self-reduction, which renders the efficiency very low.

The probabilities looming up for alternating current distribution are simply enormous. The transfer of the power of Niagara is a settled conclusion.

THE FOURTEENTH ELECTRIC LIGHT CONVENTION.

(*Continued from page 39*).

fore you in this double capacity, first as a member of this Association, to thank the gentlemen for the hospitality extended to us, and secondly as a Canadian, to thank you for coming to my native land. I think I can say to Americans here that, great as has been the progress of electricity in the United States, the Canadians have shown an appreciation of it greater almost than that of the people of the United States themselves. I doubt if any system in the world is more perfect than the system of telephones in Montreal and Toronto. I doubt if any city in the United States has such a development of that marvelous instrument as those two cities have. As to the telegraph service, somewhat connected with it as I am, I believe I may say this, that there is a larger mileage of wire, a greater number of offices and a greater number of messages transmitted in proportion to population in Canada than in any other country in the world. I can say this, too, that a lower rate—a cheaper price for transmission is uniformly afforded in the Dominion of Canada than in any other country in the world, taking distance into consideration, so that in telephony and telegraphy, electricity has found on this continent, in this Canada of ours, its greatest development. I would like to say to Canadians, though, that in certain things in the United States a greater progress has been made than here, and that is one idea I had in asking to speak to you to-day—namely, that I should draw your attention to the marvelous growth in the United States of the use of electricity in the street railway. It seems to me that no one thing has grown with such rapidity as the value of real estate wherever there has been an electric railway introduced. I know that it is alleged that the United States have the power to create wealth greater than that of any other country. I know that last year we produced in that country eight millions of bales of cotton, which sold at a price of 400 millions of dollars—a sum greater than all the gold mines in the world produced in five years. I know we mined ten million tons of iron and I know we produced this year an enormous crop of wheat. These are great accumulations of wealth, but they sink into insignificance compared with the increased value in real estate wherever an electric railway is promoted. There has been a greater advance in Boston in the value of real estate by the establishment of the West End Railway than Boston ever made by any other influence. I saw in Minneapolis and St. Paul, those two wonderful rivals that we see struggling to get ahead of each other all the time, a greater growth in value and a more perfect system of communication than by any other means possible; so at Tacoma, so at Spokane. It is strange that in Montreal, of all cities in the world, that is only beginning to be realized. I want to impress Montreal and all other cities with the great advantage that comes from this marvelous method of propulsion. Still, I want to impress on my friends in Canada the advantage that the electric system has in the transmission of power. I was in Boston on Friday and stood in one station which had a potential of 20,000 horse-power—a power so vast as almost to be beyond human conception. Fancy, if you can, 20,000 horses under one cover, saddled and bridled, and ready for a start. Fancy the forces that were latent in that potential under that roof, and yet away off in some distant avenue, by some delicate wire, it was necessary only to touch the button and—the power did the rest. So it would be in Montreal. It seems to me I do my duty as a former citizen of this place and still somewhat interested in it, in drawing the attention of the residents here to the fact that they possess the potentials of power almost beyond any city in the world. In the great rapids above them and below them are forces which, if applied by electricity, would be of the greatest advantage. I know of no city that has such enormous facilities for the creation of electricity as this city has. I know of no place in which power can be transmitted so perfectly and completely as in this city, so that a delicate wire running over a house might work a fan in a sick room and in the next block might lift a trip hammer; so that a sewing machine or half a dozen of them, or 50 of them, or a factory, could be run from the St. Lawrence and Ottawa by the transmission of this power. An optician might grind the most delicate piece of glass in a small lathe before him, and even the running of a sewing machine and the rocking of a cradle might all be done by electricity. I think I can see in the marvelous growth of that power, that the fecundity of the French race will be even increased by the facility of rocking the cradle by electricity. (Laughter.) Perhaps when that day comes the success will tell a different tale. I hope it will. At any rate we want something to stimulate this country to grow a little faster. I have great gratification, indeed, in believing that you will have a most joyful time. So far as the city itself is concerned, I have the belief that your presence here will stimulate and draw attention to this question of not only having every street equipped with electric railroads, but making every ripple on the rapids contribute to the wealth of the city. I cannot but think that the great progress that electricity has made and your presence here, will bring popular thought and popular opinion to bear on this question of the use of this tremendous force that lies now idle, so far as its transmission is concerned. If that should occur it would all be attributable to the fact that the National Electric Light Association held its meeting in the city of Montreal. Montreal has facilities for manufacturing greater than any other city in the world. It has got raw material at its hand. It has got the cheapest and the best labor. It needs only the touch of electricity to make it the greatest city and the greatest country under the sun. (Applause.)

President C. R. Huntley, then delivered the following address:

THE ADDRESS OF THE PRESIDENT.

My predecessors in this chair have seen the Association advance in strength and worth, outliving trials and vicissitudes, to emerge on a wider, larger field of usefulness and opportunity. I do not believe that there is another industry in the world which has passed through such quick stages of evolution as ours, and become so soon established in popular favor and general prosperity. But we must not assume that because electric lighting has set its feet upon the rock and laid its deep foundations, nothing more remains to be done save to pursue the policy and practice of the past. On the contrary, I deem it necessary to say here that my own responsibilities as a central station manager compel me, as never before, to be watchful of the tendency of conditions and inventions in the art, so that I may in any degree profit from my own hard-won experience. If, as central station men, we are to secure adequate return on the investment committed to our care, it becomes us in every way to study closely all the ideas that will give higher efficiency of plant and higher economy in operation. There was a time when some of us expected to grow rich out of abnormal prices. To-day there is not one of us who does not know that his hopes of dividend lie wholly in the skill with which the best business ability and the soundest engineering are applied to the work in hand.

I take it that it is now pretty well recognized among intelligent station managers, that the day has passed when they can limit themselves to one class of service or apparatus, to the exclusion of all others. To obtain the fullest measure of success and the largest return from the capital invested, they must be ready to supply any demand made upon them; as a result, the successful station, even to-day, is gradually assuming a composite character. This compositeness is manifesting itself first in the variety of apparatus, as a result of the selection of the machines best adapted to a given class of work, and independent of any particular system. One cannot help seeing in this change from early practice a step towards increased efficiency of station operation, as well as a good reactive effect upon the manufacturers of apparatus, who are thus all placed on a common basis of competition. But, besides a compositeness in detail, signs are not wanting that no one method of distribution from a central station can, in the large majority of cases, be adequate to the demands that are made upon us, and that to meet them in a manner to insure a profitable business requires a flexibility and variety in methods of distribution, the full extent of which is to-day hardly recognized. To reach the full limit of its usefulness the central station should avail itself of methods which, I believe, will finally resolve themselves into what may be called the "zone system" of distribution.

The idea embodied in this zone system can best be explained, perhaps, by taking a concrete, practical example, and for this purpose the present occasion makes the city of Montreal an interesting one. Setting aside for the moment the possibility, and even the probability, of the transmission of electrical energy to the city from the power obtained at the Lachine Rapids, we will assume a station erected at the water front of the harbor, as indicated on my diagram. It will, I believe, be granted that up to within a distance of one-third mile radius the three wire low tension direct current system of distribution answers fully every requirement of simplicity and economy, and hence if, with the station as a center, we draw a circle having a radius of one third mile, we shall have a "zone" supplied in the most economical manner for every class of light and power apparatus now familiar to us.

Coming to the districts beyond the first zone, we are necessarily obliged to have recourse to higher potentials for the feeders, and the selection of the proper potential is a matter of simple calculation. We may, for the sake of this argument, call it 500 volts. Continuing on in this way, in steps of 500 volts, successive zones, half a mile across, might extend in the aggregate to several miles, without reaching the limit of potentials which have been found to be perfectly feasible in practice.

In the example no reference has been made to the nature of the current employed or to the method of local distribution. Evidently we may readily resort to the alternating system, employing converters, to reduce or raise the potential, or to the direct current to reduce from high to low by motor dynamos. Either one is perfectly practicable. Perhaps some of our new school of electrical engineers will show us how to use the same circuits for both alternating and direct currents.

But, whatever system be employed, I deem it proper to record here my conviction that the most economical way to distribute the current to the consumers at the point of delivery is by low pressure conductors, in contradistinction to the plan now generally in vogue of giving each customer a converter of his own or, in the direct system, a separate motor-dynamo. I need not here enlarge upon the train of reasoning which has led me to this conclusion, but I may remark that I am strengthened therein by my own experience in Buffalo, where we are now introducing gradually 200 light converters and replacing the smaller ones heretofore employed. Nor do we propose to stop there, but expect to install converters of still higher capacity, distributing the current to a number of customers by low pressure mains centering at the large converters. As addressing myself to practical men, I need not refer to the fact that it costs practically no more labor, etc., to put up a 200 light converter than it does a 10 lighter, while the initial cost per light is less in the case of the larger converter. In these conclusions I am only recommending for large amperical areas what, I believe, is now recognized abroad by Ferranti and others, whose work, like our own, will eventually lead to the establishment of large converter sub-stations from which low tension wires will supply the surrounding districts.

The allusion made to the motor dynamo system for converting the direct current from high to low potential may to some appear nothing more than the citing of a possible method in view of the existence of the alternating system, well tried and ready at hand. But without wishing in the least to detract from the merits of this system, which has probably done more to popularize electricity than any other, I cannot, as a practical man, conceal from myself the fact that, taking everything into consideration, the low tension direct current system of distribution is the most flexible within its area and serves the greatest variety of purposes. I do not think that any one can successfully contradict the assertion that to-day no other system can, with equal efficiency, take care of arc and incandescent lamps, motors (large and small), storage batteries, electric heaters, etc.

In making this statement I desire to be understood as referring to the present condition of the art, the only condition which, as practical men, we ought to consider in matters of this kind; but I hope the time will soon come when the same can be said of the alternating system. There are still other methods which suggest themselves by which the "zone" system could be effectually carried out, but those indicated are sufficient to demonstrate the idea I endeavored to convey.

After the intelligent station manager has declined upon the nature of his apparatus and the initial capacity of his station, his most important consideration is the allowance to be made for future growth. Look back, some of you, and recall the mistakes made, but which were brought about by the enormously rapid growth of the industry. I need not go out of my own experience for such an example. Less than two and a half years ago we erected in Buffalo a new station considered far too large for even the most extended future growth. Some of my colleagues shook their heads. Yet even to-day it is being worked to its fullest capacity and provisions will soon have to be made for more facilities.

What, then, may be asked, shall we determine upon as the unite time limit of growth for which provision should be made? Shall we build our stations sufficiently large to take care of the demands of five, or ten, or 20 years hence? This is a most serious question, and one to my mind as important as the selection of the proper station apparatus itself. I note the erection of several stations abroad, and some here, designed to supply the demands of 15 or 20 years hence. Without wishing in any way to detract from the laudable enterprise and faith exhibited by the promoters of these stations, a calm survey of the past, present and probably future condition of the art, leads me to believe that the setting of so long a time limit as 15 or 20 years is inadvisable. I need not remind you in detail of the changes in methods and apparatus that have been effected during the last five years, by which the efficiency and output of our station has increased, and if to this we add the fact that already new methods, such as those pointed out by Mr. Tesla, may at any time increase the present lamp capacity of our stations five and ten fold, I think we may be justified in placing five years as the limit of time, to make provisions beyond which may involve expenditures, the benefits of which may not be realized.

These are matters we are endeavoring to settle for ourselves. It is to our interest to settle them. So, too, with the underground question, but there we have gratuitous advice, assistance and abuse to such an extent that less progress is made than in any other part of the work. We all want to put our wires underground where the number is so great as to make them unsightly or unwieldly, and not a few of us have been parties to experiments now written off to profit and loss. As soon as the time arrives when every house has its wiring as a matter of course, just as now it has piping for water and gas, it will be a comparatively easy matter to lay down comprehensive underground systems. But at the present time the customers for current are scattered and not continuous. The man with enterprise enough to take electric light and power soon moves into a larger store. His successor does not want the service, but gropes along with kerosene or spoils his goods with gas. Cutting out disused underground service is an added risk and expense, and 10 lights could be installed on overhead circuits for $10, where with underground the cost would be $50. It follows that in any city—Buffalo, for example—we shall not make one underground connection where with overhead wires we should have made 20. Now, are the public or are we the greatest losers? The public, I think. It is as unreasonable in most instances to demand underground wires as it is to expect every railroad to make every crossing above or below grade. But for our overhead wires America would not be to-day the great land that it is of electrical triumphs; and, while I hail with delight every advance in the solution of the underground problem, I hope long to gladden my eyes with the sight of a pole well set and a wire well strung.

Another stirring question of the hour is that of municipal ownership. Now, it has been taken for granted that electric light men are against this plan, tooth and nail. How absurd that notion is. Because we represent the latest development of invention and industry, we certainly do not forfeit our pride as citizens, nor lose our interest in the advance of social science. It would, in fact, be difficult to find a more progressive, well known body of men in America to-day than they who have put their money and energies into electric lighting. They are neither crusty nor cranky. But when any movement has been started for the betterment of the communities in which they live some of them have been at its head. Now, is it strange that such men should object to the confiscation of the properties they have built up and that are beginning to pay? Is it strange that they should ask for these new theories in social economy to be tried on something else first? Many of them have grave doubts as to the accuracy of the figures that are supposed to prove that municipal plants pay. Others of us have great objection to any taxation, the proceeds of which are to set the municipality up in a commercial business. Others, again, believe that the best results are reached in any industry when it is freest from political influences and is left to the uplifting and perfecting impulses of individual enterprise.

I believe that the most conclusive answer we can make to the sophisticated arguments of an ill-disguised socialism, presenting itself in this municipal ownership scheme, is to give the very best service possible at the lowest rates compatible with fair profit. Some of the prices we now obtain are so low as to exclude any profit at all, especially when repairs and reconstruction are considered. But here again we may help ourselves out by native wit. Every company in the ranks of this Association ought to ascertain for itself, at regular intervals, just how it stands as an industry. A good deal of apparatus in use is decidedly inefficient. Overhaul it. If necessary, throw it out and put in better. Above all, adopt a good system of bookkeeping. It has been a source of much gratification to me to see in the pages of one of the leading electrical journals, recently, a most valuable series of articles on central station management and finance by Mr. H. A. Foster. I trust that every electric light man will read those articles, if indeed he has not done so already. The subject is admirably treated from the practical standpoint, and it is impossible not to derive good from the many hints and suggestions, while the various forms and blanks shown may be adopted with much benefit. Electric light securities are to-day far from enjoying the esteem in financial

circles that they deserve. This is due in a measure to speculative investment and to over-capitalization in the past. But it is also attributable very often to the poor system of accounts employed, and I am glad to see the subject thus receiving attention. If we know what our current costs we know what we can sell it for, and unless that information is obtainable from our office books, engineering will go for naught and capital required for new work will stand aloof.

In conclusion, I would urge that the Association determine upon meeting only once a year. Even if it were not impossible to recover in six months from such overwhelming hospitality as we are now the recipients of, I believe that the time has gone by when half yearly meetings were necessary. Once in twelve months is often enough for us to come together for the comparison of our experiences and the report of further refinements in the detail of the industry. The mere fact that frequent reunions are no longer necessary is in itself a hopeful sign, for it tells of stable and settled conditions and of activities that now require our presence at home pretty well the year round.

Gentlemen, I thank you for your attention and I trust that your deliberations in the coming week will be characterized by the same earnestness which has characterized them in the past.

The President then read an invitation from McGill University to the members to visit

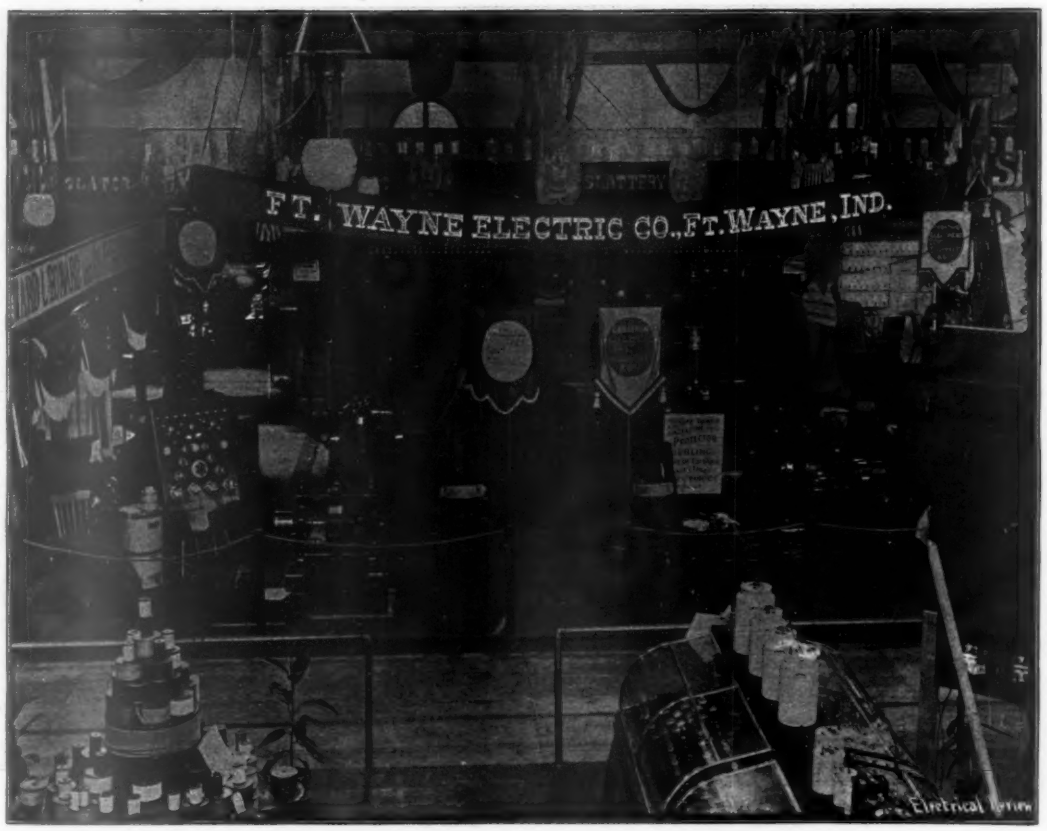


FIG. 8.—VIEW OF FORT WAYNE ELECTRIC COMPANY'S MONTREAL EXHIBIT.

the library, museum and buildings of the University; invitation from the Art Association of Montreal to visit their gallery; an invitation from the Quebec and Levis Electric Light Company, to visit its works at Mont Morency Falls; an invitation for a trip up the Richelieu River; an invitation from the Harbor Commissioners, to join them in a trip up the Lachine Rapids. The President added that there were also several garden parties which had been announced.

On motion of Mr. Seely, the invitations were received and filed and a vote of thanks extended.

The President: When the invitations were sent out, knowing that we would come to Montreal, the executive committee instructed its secretary to invite, as a body, the American Institute of Electrical Engineers, the New York Electrical Society and the Society of Electrical Engineers, of Brooklyn. The invitation has been accepted.

We are also in receipt of a letter from the Director-General of the World's Fair, authorizing Mr. Hornsby to represent him here in connection with the Fair. He will present the subject to you when the matter of the World's Fair comes up, for which we have a committee. I wish to urge upon every member to be present at our meetings. We have many interesting papers and there is ample time for pleasure in the afternoon, and we should have every man, whether an associate or active member, on the floor during the discussion beginning at ten o'clock.

The convention then adjourned until September 8, at 10 A. M.

Second Session—Tuesday, September 8.

The convention met at 10 A. M., President Huntley in the chair.

The President: The first thing in order this morning will be the reading of the report of the Committee on Relation Between Manufacturing Companies and Central Stations, of which committee Mr. Marsden J. Perry is chairman.

Mr. Armstrong: There is a little error there. We have been transposed. I am chairman of that committee, and Mr. Perry is chairman of the Committee on World's Columbian Exposition. Before reading the report of the Committee on Relation Between Manufacturing Companies and Central Stations, I will, with your permission, present a letter that Mr. Shaw, of Eau Claire, Wisconsin, has sent me from the special committee, appointed at the last convention, on amendments to the constitution:

EAU CLAIRE, Wis., Sept. 3, 1891.

The special committee on revision of the constitution appointed by yourself, pursuant to a resolution adopted at the convention of the National Electric Light Association, held in Providence, R. I., in February, 1891, have had under consideration the question of revision of the constitution, and beg to report as follows:

That, in the opinion of the committee, the fundamental features of the constitution and the general plan involved, should not be modified or changed, and that, while the constitution itself is susceptible of improvement in questions of detail, and if intelligently amended may be made more symmetrical, yet, as the constitution has not been in existence a sufficient length of time to give it a fair trial, it is our opinion that any changes, amendments or modifications at this time are undesirable, and we recommend that no amendments to the constitution be submitted at the forthcoming convention.

Respectfully submitted,

GEORGE B. SHAW,
E. A. ARMSTRONG.
Committee on Amendments to Constitution.

Mr. Shaw said that he was detained because of engagements over which he had no control and could not be here. I move that this report be received and the committee be discharged.

Mr. Weeks: I second that motion, and with the permission of the chair in so doing I want to say that I am very glad that this committee has reached this wise conclusion. I take it that that state, that corporation, that association, that is continually dickering with its organic law is in a bad way, and that our constitution should be allowed to stand, at any rate until it has had that seasoning of time which will enable us to determine wherein changes are necessary. When the Constitution of the United States of America was adopted you may remember of having read in history that various objections were raised to it. It was held even by some that under that Constitution there would be nothing but ruin ahead of the States. But those croakers were not listened to, the Constitution was given the seasoning of time that it required, and it was found that it needed but comparatively a few simple amendments. (Motion carried.)

The President: The next is the report of the Committee on Relations of Parent and Sub-Companies.

Mr. Armstrong said: As this committee reported at the last convention so it reports to-day. No matter has been brought to its attention. One of its members asked yesterday, "What excuse can we give previous existence or make for its continuance?" We have all realized the possibility of great good through this agency, but there has been but little attempt to utilize it. Unless something is to be accomplished in this field that demands the most thoughtful care and attention (and is the one point where our interests are to-day), the committee ought not to be continued.

Mr. Weeks: I move that the Committee on the Relations between Parent and Sub-Companies be instructed to formulate a definite plan of procedure for the protection of central station companies, and to prepare the necessary articles of agreement, and report the same to this Association in executive session at its next convention.

Mr. Francisco: I second the motion.

The President: You have heard the motion of Mr. Weeks, seconded by Mr. Francisco. Is there any discussion?

Mr. Weeks: In my opinion, along the line of work in the mind of this Association when this committee was appointed lies the salvation of the central station interests of America, and I think that the time has come for some plain talk on the subject. I propose, therefore, to briefly read you the situation. You will remember that the early history of electric lighting was phenomenal, in that the people were so ready to believe everything that was promised for the new industry, and so confident in its value as an investment. The wonderful achievements of Bell, Edison and others in telegraphy and telephony did much to pave the way for the introduction of the electric light. Such was the attitude of the public mind that companies were readily organized for central station work, and the extravagant statement of parent companies as to the performance of machinery, of their apparatus and of their manufacture were received with a cordiality not very complimentary to the wits of investors. Manufacturers of apparatus claimed for it a high efficiency, in one case even as high as 105 per cent. Declarations were made that, with the exception of brushes and commutators, which might need renewing every two years, it was practically indestructible, nay, it was even held that it would improve with use, and they set their price so high on that that these qualities seemed assured. They guaranteed to purchasers: First, high efficiency; second, patent protections; and third, exclusive rights in their respective territories. They assured investors that the new light could be produced cheaper than gas, and in order to compete with gas and increase the demand for the apparatus, they advised continual reductions in rates of service. Companies speedily organized in the larger cities, and capital smiled on electric light investments. It was soon found, however, that various so called systems of electric lighting were extremely crowded, and the apparatus was so short lived that investments must be increased to meet the demands for improvement and for renewals, for which the parent companies made little if any discounts. Still, so confident were the local companies in success during future years and so blindly credulous in the good faith of manufacturers, that the additional capital flowed in and the parent companies were enabled to enlarge their producing powers and to increase their dividends. In the course of time it began to appear that the second claim of the parent companies, in consideration of which local companies had paid such high prices, could not be maintained. Patent protection was not given. The pioneer enterprises saw their field invaded by apparatus employing the very devices for which they had paid so liberally upon the assurance that those devices were controlled by the grantors. Meantime capital was beginning to discover that electric light investments were often bottomless abysses. The crude and imperfect apparatus, itself short lived, necessitated constant renewals, its extreme delicacy necessitated frequent costly repairs, and the cut-throat competition instigated and supported by rival manufacturers using practically the identical apparatus, affected public confidence. Most of the profitable fields had been occupied, and although the electric light had demonstrated its desirability and its superiority over gas, the rate of service was necessarily much higher, owing to the greater cost of plant, operation and maintenance. As the parent companies found themselves with immense producing powers, and without sufficient demand to employ them, the very powerful ones began to purchase the business and factories of the weaker, presumably to clear the field of competitors, and the temptation to violate their contracts with pioneer local companies proved to be strong. It was observed with a few of these systems that their purchasers had placed them in charge of their most experienced men, and after fortifying the weak points by the use of their own special devices, intending to sell this apparatus at greatly reduced prices in fields already fully occupied by their own apparatus, which had been bought at high prices by companies to whom they had promised protection of all kinds. What treachery can be more abominable for those who have borne the brunt of the new industry struggling for a foothold, who had literally enriched parent companies by their own bleeding, who had created the demand for apparatus that patent companies had to sell, and who, through their own experience, had shown inventors and manufacturers wherein their apparatus could be improved and cheapened? But worse treachery followed. The most outspoken enemy of the electric light has always been gas. The gas companies were heavy corporations, who had fully occupied the field of lighting for many years and had fattened upon the profits yielded by the industry of which they had a monopoly and which required a plant comparatively simple in construction, easily and cheaply operated and maintained and employing raw material, the residual products of which were made to yield a handsome revenue. When the electric light entered the field it labored under the enormous disadvantages of costly, complicated and imperfect apparatus, unknown operating expenses and depreciation, and no bye-products. Yet the gas interests, recognizing the new light as a formidable rival, fought it in every way available to a long established, powerful and wealthy monopoly. The parent electric companies were bitter in their denunciation of the methods employed by the gas interests in their efforts to prevent the establishment of the new industry, and until their revenues from local companies began to fail, assisted the latter in the struggle in every way which did not seriously affect their pockets. At the present time, Mr. President, the condition of affairs is changed. The gas interests are still opposed to the electric light. But, as this has shown that it has come to stay, gas companies all over the world are preparing for a new effort. They will wage war with our weapons; with cheap apparatus furnished them by our parent companies. They will endeavor to so demoralize the field of electric lighting that legitimate business cannot stand the strain. Parent companies are selling to the gas interests, and they have the effrontery in their advertisements to boast of their success, apparatus that employs the very devices whose exclusive control had been guaranteed to the interests that the new purchasers are straining every nerve to kill. And this is being done at a most critical period, when depreciation is becoming known at its full value, when, owing to the general depression, market values of service are at their lowest, and when there is a strong tendency on the part of municipalities to demand of the electric industries expensive, doubtful changes,

and to curtail their privileges and reduce their rights. The manufacturing companies are indirectly and directly promoting this tendency and are inciting municipalities to purchase plants, thus depriving local companies of that profitable service which they themselves have created. To the 100,000 stockholders in the local companies of America is chiefly due the establishment of the new industry. They have produced the sinews of war and by them the battle has been fought and won. From them parent companies have derived support which has made them what they are. For this veteran service and this timely support what return do parent companies make? Having possessed themselves of many millions of our hard-earned money, they are now violating their most sacred obligation and betraying us to the enemy. You, Mr. President, like Agricola Senex, in the fable, have nurtured a viper in your bosom. You have created a Frankenstein monster, who now turns his hand against you, and I warn you, central station men of America, that if you would save your millions you must prepare to carry the war into Africa with respect both to the gas and to the parent companies. These two interests, with their pronounced porcine proclivities in common, must both be considered in this connection. The gas companies have, not without a certain assurance, fought well to concede to us the period of experimentation, believing that through the treachery of the parent companies they could easily step in and capture the business when its permanent value became known. After we have paid the score and quaff the froth they, like the thirsty soul in Virgil, intend to seize the bowl and drain it to the dregs. But, Mr. President, if to them we seem vulnerable on account of the prices which we have paid for apparatus, let us not forget that they too have their undipped heel. Their plants also can be duplicated at much less than their original cost, and by improved processes their rates can generally be greatly reduced and still leave a larger margin of profit than most of us enjoy. Indeed the gas field is a most attractive one. For while gas is fast losing its place as the leading illuminant, it is certain to be the fuel of the future, and fuel will always be more generally and largely used than light. Fuel is everywhere a necessity, while light is largely a luxury. I, therefore, advise every one interested in electrical central stations to investigate the gas business, subscribe for the gas journals, and let slip no opportunity to gather information regarding this great industry. With regard to the parent companies, I will say that you central station men who have created these companies have the power to check their rapacity and, if need be, to destroy it. Your interests are identical. You have a peculiar element of strength in that you do not seek to serve the same customers and can, therefore, never be brought into conflict one with another. Your investments now aggregate upwards of 100 millions and with stockholders among the best business men—the leading men of affairs in America—you have the power to inaugurate a movement and carry it forward which will be irresistible. Why should this army of producers, with their 100 millions of active and productive property and their inexhaustible resources, submit to the extortions and treacherous attacks of a few syndicates who are little more than brokers in material, whose *bona fide* investments aggregate about 25 millions and whose factories can be duplicated—yes, and greatly improved upon for one half that sum? Let us enter into a compact whereby we will pledge ourselves to purchase apparatus only of those companies who will treat us fairly, and in case we cannot get such fair treatment, in case we are met by a combination, a trust or a pool on the other side, let us pledge our united support to a new manufacturing enterprise which will enter the field with this guaranteed business to rest upon, and, Mr. President, if, as a last resource, if the worst come to the worst, let us, with our upwards of 100 millions of investment, call into a common fund from one to five, 10, or even 20, per cent. on our investments, and standardize our apparatus and do our own manufacturing. You, Mr. President, well know there are already upwards of 12 millions pledged in writing to this movement. Your committee should push this work forward with all possible vigor, as it cannot fail to result in the greatest good to the greatest number. (Applause.)

Judge Armstrong: As chairman of this committee, I have listened with a great deal of interest to what has publicly been expressed, and so ably expressed, by my fellow member, Mr. Weeks. Since I have been a member of this Association this one question has been discussed with more vigor outside the meetings of the Association and when we have met one with another, than any other question; and indeed, it should be discussed, not only outside but inside, because these very evils that he speaks of are the most dangerous things that we have to encounter in this business in which we are engaged. Now, there should be no conflict of interests; there should be no throat cutting in this, because it is absolutely essential that we establish firmly this industry. Have any of your companies attempted, outside of your own circle, to place your securities? Have you attempted to do business outside of your own immediate circles—those with whom you are particularly interested? If you have, you have been met by just exactly these things that shrewd business men could see. If we are bound to be subject not to fair competition, not to the ruling markets, not to anything of that sort, but if we are bound to be subject to raids, where will it end? How will the business be advanced? How will enterprises be exploited? How can we carry on, as we hope to do, the business in which we, as pioneers, have engaged? It is very natural that if we, as lighting companies, come into a territory and propose to succeed some other method of illumination, it is very natural that that method of illumination should seek to oppose us. No matter if they realize, as most invariably they do, that we can give a better thing, better suited for the purpose, do better work in this line, it is not natural that they, representing their stockholders, should sit by quietly and let us take the field. They might as individuals, as citizens, condemn the fact and lament the fact that their interest as stockholders, as directors, as managers of another thing, make them oppose this advance, but, nevertheless, they will oppose it, and when they can be met with the encouragement, with the assistance, aye, with the direction of those who ought to be the last to encourage them, those who ought to be the first to discourage them—I say, when they can be met by that, it is no wonder that our enterprises are hampered as they have been and as many are to-day, represented here upon this floor. Now, Mr. President, it is not a desirable thing that any of these methods that Mr. Weeks suggests should be engaged in by us as corporation or by us as individuals. Not one of them is to be commended. I will take that back—one of them is to be commended—that we engage to deal with those who will deal fairly by us. That I do heartily commend. But the others I cannot commend; and as I take it he does not commend them either. No more does he commend the necessity that there is to build fortifications, to raise armies, to engage in war. No more does he deem it an advisable thing to take physics, and yet all these things, under given circumstances, are necessary, and as I understand it, the circumstances are with us to-day, and if we suffer them to go, we will be in the position of a State that permits a host to fully arm and equip itself and come against it, and it remains defenceless and unprepared. We will be in the condition of a man who suffers the inroads of disease to come so that there is no possible hope of recovery, no matter how much he may subsequently physic. Let us at this time diet ourselves. Let us at this time prepare, so that encouragement will not be given to those who seek to come against us. As I understand it, Mr. President, when this committee was first appointed at Kansas City, it was with the idea of formulating some plan, doing something, only, however, because it was supposed that central station men would come to them with suggestions and explanations, and experiences, so that we might before this have gone on to prepare against this day that seems now upon us. As I take it, this resolution that Mr. Weeks has offered means that now, we, as an Association, through our committee, shall prepare some definite plan by which, because of its object, we agree firmly to stand, and by which we propose firmly to establish the business of our constituents. (Applause.) I am heartily in favor of taking the most vigorous method, using the strongest possible means that we can, firmly, to establish our business, and I am more in favor of that from the reason that any such act cannot by any possibility hurt any legitimate enterprise. If that be so, no man can condemn what we suggest doing to-day. (Applause.)

The President: Is there any other discussion on the subject. This is a very important one, gentleman; I would call upon Mr. Wilmerding, of Chicago, to say something on this subject.

Mr. Wilmerding: I do not think, Mr. President, that any central station man can differ with Mr. Weeks and Judge Armstrong on this point. We all know what experience some of us have had. Personally, I cannot say that we have suffered very much, and a combination such as has been suggested would take care of the future. That is what we want to look out for. I think that a gentleman present who has had more experience in this line than I, can say more to the point than I can—Mr. Francisco.

The President: We would be glad to hear Mr. Francisco.

Mr. Francisco: I am rather peculiarly situated on this question. I have been hauled over the coals for the last two years for this very thing. I have been furnishing light at about one-third the cost of producing it, on account of this kind of guerrilla warfare. So that I know something about it from actual experience. I am now, as I was at Kansas City, and as I was at Providence, strongly in favor of this movement, and I hope that the central station men of America will take hold of this as a body and carry it through as a body, united and strong, and there is no question in my mind, if they will do that, but that they will succeed and that they will support themselves without any difficulty. It is not, as I look at it, a warfare. That is not the idea. It is simply self-protection. That is what we are after and nothing more. We do not want to inaugurate a warfare against the manufacturing companies or the parent companies. That is not the idea. But we want to simply say to them when we have purchased a thing we wish to have the right to use it. What we want is protection. We want them to comply with the agreement they made with us, and we want the power if they do not do it to compel them to do it. That is the position I take in this matter, and the position that all central station men should take. Now, here is a station established. I go to my people asking them to invest money. What object is there, they ask, in investing money? How do we know but what there are going to be three or four parent companies coming and establishing plants, just as they have done already, and compelling us to keep buying them off all the time? Now a company that is organized and started in business, especially in places not large enough to sustain two companies, the only object in establishing the rival company is to compel the original company to buy them off or to sell apparatus to some opposing company. If the second company can raise enough money they will wipe out the first company and go on until the parent company comes in and wipes them out. Now, with this arrangement that has been discussed here and was discussed at Providence there is a united effort. The parent companies and the manufacturers understand that it is not warfare, but simply self protection, and that if they deal squarely and honorably with the central station men, they will secure three times the patronage from those central station men that they can get by selling one or two plants to different parties scattered over the country. I have, unfortunately, been drawn into this controversy about municipal lighting, and have been very flatteringly noticed by some of the municipal papers over the country in a way which is not very cheering, but I have got so accustomed to it now, that I do not think anything about it. In fact, if I do not see some article in regard to my theories and my quaint idea on municipal lighting in some paper somewhere about every day, I think it must be that the matter is falling off and that the principle of municipal lighting is rather going backward. But the same principle is involved there that is involved here. A city gets the idea that it can produce lights for about half of what the corporations can produce them for. Some parent companies go to the officers of the city and propose to put in a plant. Now, they are not only going to furnish the city lighting, but they are going to put in lights and do commercial business right in direct opposition to the local company, whose capital is invested there and whose rights that very city has guaranteed by contracting with it to do that business. Now, after they have invested their millions of dollars in that property, this parent company tells the city that it can produce its lights for half of what the local company is charging for them. Now, that is entirely wrong, and this combination of central companies should be made to meet that point right here, whether it is selling to cities or selling to other opposing corporations, I do not care which it is. They should be met there and they should be forced to abandon that scheme and treat the local and present companies fairly and honorably. Mr. Wilmerding speaks of Chicago. I saw there was a bill introduced in the Illinois legislature allowing the city of Chicago not

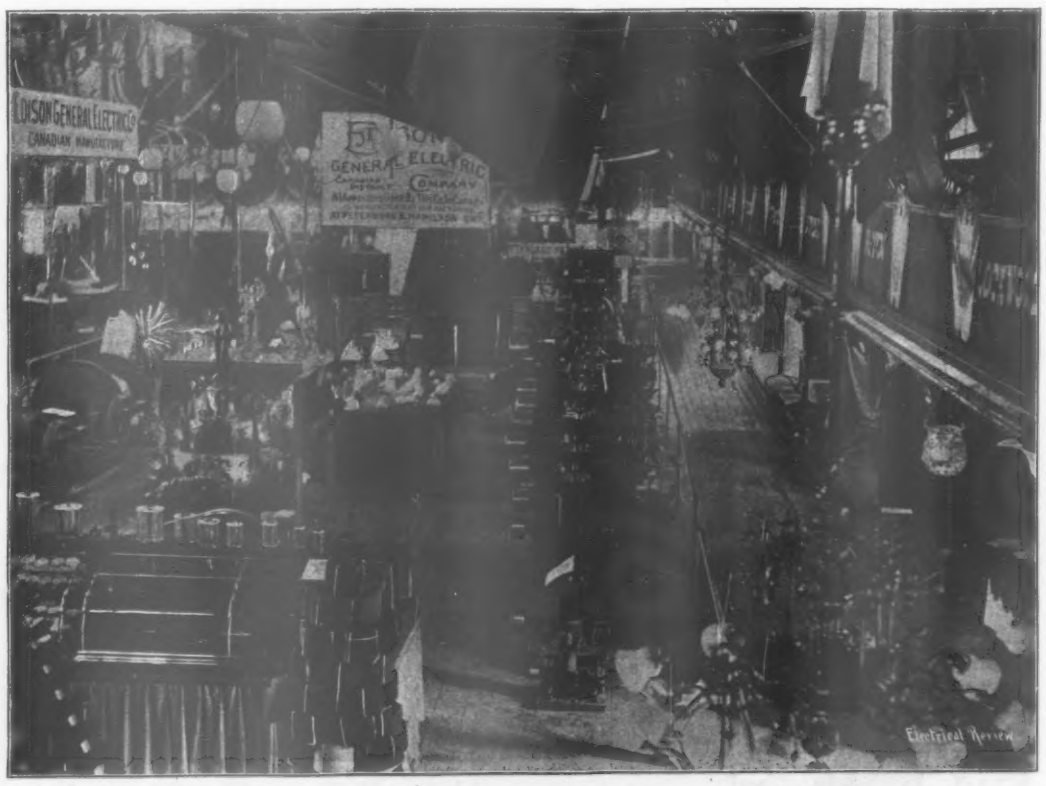


FIG. 4.—VIEW OF ANOTHER SECTION OF THE EDISON EXHIBIT AT MONTREAL.

only to produce its own lights, but to furnish commercial lighting all over the city of Chicago, in direct competition with the local company there. Now, everybody knows what the result of those things will be. Everybody knows if they can tax you and me to make up the deficiency that they can wipe out any local company, no matter how large its capital. If the city has the privilege of falling back and taxing the people, of course, there is no possibility of competing with them. I trust that this matter will go forward and that the men of this convention will take this thing by the horns and put it in proper shape and carry it forward.

Mr. T. Carpenter Smith: I have listened with a great deal of interest to Mr. Weeks', Judge Armstrong's and Mr. Francisco's remarks. I was very much interested in one proposition put forward by Mr. Weeks where he spoke of forming a company for the manufacture of apparatus. I think that in that suggestion there is a weapon that lies ready to the hand of every central station man. We know that there is enough machinery on which the patents have entirely run out which can be used for nine-tenths of the lighting in an electric light station, referring more particularly to arc apparatus. The one feature in an arc machine which has been used to sell apparatus more than another, and which has been used by parent companies, one against the other, is that of a good regulator. I have had some little experience—not very much—in arc lighting, and I have found that the best regulator of an arc machine is a good big load (applause). Now, I think that there is not a central station in the country but that has bought and paid for enough patent regulators to take care of all their small circuits—all their cut circuits—and I think if this committee put in the hands of every central station information that would enable them to buy machines which would run their full circuits, and let them keep those for which they have already paid heavy prices to run their cut circuits, that you have got a weapon to bring the parent companies to a sense of what it means to lose nine-tenths of their business at once. I feel that this committee, if it be continued, should look at the matter in that light. It is information of that kind which we want circulated among the central stations. I know station after station that has enough apparatus to do its whole business, which it cannot use on account of defects in it—its old apparatus, which could be fixed up and do efficient work if its men knew how to fix it. But the parent companies tell them it would be necessary to buy new stuff. Advice to buy new material is what they are always met with. What the central station wants is information which will enable it to use its old stuff that it has already bought and paid for. I believe there is enough apparatus to-day in central stations to do all the business for 10 years to come without buying another particle from the parent companies (applause).

Mr. Nicholls: I am very much interested in the question at the present time, and I have listened with a great deal of interest to the remarks made by Mr. Weeks and by Judge Armstrong. I must say, however, that I have a good deal of sympathy with the parent companies, because, as business men, we all admire a company that is aggressive in pursuit of business, and, while I admire their aggressiveness, I must say that I question the policy of their procedure in these matters. It is far better, it seems to me, to have a healthy, vigorous company in any one locality than two or three competing companies that are slowly dying of inanition and who are cutting each other's throats. But it seems to me, sir, that this matter has been so well expressed, that the different arguments have been so well put, that it would be a pity, considering the smallness of the attendance at this meeting, if the rest of the members who have not an opportunity to be present here to-day should have to wait until the minutes of this Association are printed in due form, and on that account I beg to move that the paper by Mr. Weeks, with the remarks of Judge Armstrong added thereto as taken down by the official stenographer, be printed in the form of a pamphlet at the earliest possible moment out of the funds of the Association and sent to every active member.

Mr. Seely: Is this the final report?

The President: I will entertain your motion, Mr. Nicholls, later on, after consideration of the report of the committee.

Judge Armstrong: In reply to Mr. Seely's question, I would simply say that the committee's report was that nothing had been offered by the membership of the Association to the committee, and under the line of its appointment it did not understand that these various things could be entered into by it. It was to stand more as an arbiter between parent and sub-companies where this question arose, and while outside there has been the greatest amount of muttering and discontent and feeling, as has been well expressed here to-day, yet, so far as the committee is concerned, nothing had come to it. There was no necessity for the parent company to come; it did not care to; it wanted to be let alone. None of the sub-companies seemed to understand that they were to bring in their grievances, if they had any, to this committee, and the suggestion of the committee was that if it should be continued there should be some definite direction given to it to take the initiative, or else that the committee be no longer continued as one of the committees of this body.

Mr. Seely: This Association need not take any action of the body on this subject, except to receive the report of this committee and either continue it or discharge it.

The President: The matter under discussion is simply the report of the committee, and it is for the body to determine what to do with the report of that committee.

Mr. Burleigh: If I understand the matter, Mr. Weeks' motion is before the house that this committee be continued.

The President: Will you please write out that motion, Mr. Weeks?

Mr. Weeks wrote out and handed to the secretary the following motion:

I move that the Committee on Relations Between Parent and Sub-Companies be instructed to formulate a definite plan of procedure for the protection of the central station companies and prepare the necessary articles of agreement, and report the same to the Association in executive session at its next convention.

The motion was seconded by Mr. Seely and carried.

The President: Now, Mr. Nicholls, we will entertain your motion.

The Secretary: Mr. Nicholls' motion is that the report of the committee and the discussion thereon be printed and distributed at the earliest moment.

(The motion was carried.)

The President: I will call now for the report of the Committee on Data.

Mr. H. M. Swetland: In the absence of Mr. DeCamp I have been requested to prepare and submit the following report relative to the comparison of economy in the generation of power.

REPORT OF THE COMMITTEE ON DATA—COMPARISON OF ECONOMY IN THE GENERATION OF POWER.

Your committee finds almost a universal opinion among managers of electric light stations that it is impossible to record actual expense in generating power for this service, owing to the fact of frequent changes of load and short and irregular runs. The aggregate coal bills from week to week may be compared with the charges made for lights delivered, but whether his aggregate compares favorably with the coal actually necessary to perform this work, or whether it be twice the amount necessary, is often considered an unanswerable question. In most instances where records are kept the date begins and ends with the number of pounds of coal burned and the number of lights delivered, no attempt having been made to record the performance of boilers and engines separately; and, while the data furnished might prove the economical operation of the aggregate plant, they often show a wide margin for waste, which may be either in the boiler, engine or dynamo room.

The committee are, therefore, confronted with this fact: A large majority of the stations do not make records of the performance of their machinery in sufficient detail to be of service in the matter of comparison, and, while many reports have been received covering fully the work contemplated, sufficient data has not been received to form a complete report that can be submitted at this meeting. The work of the committee must therefore be directed to the encouragement of simple duty tests, and, if we may suggest it, to put in directions for such tests. Until it shall have been made a part of the routine work of a central station to keep these records, the "duty tests" will continue to be the "mole hill mountain" of the management, and the difficulty in making these records will be over-estimated. Once entered upon, the simplicity of the work is apparent, and the management finds this report as indispensable as the others.

In this respect the work of the committee has been misunderstood. We do not advocate a pony brake and engine indicator on every piece of machinery, or a corps of clerks and experts to make instantaneous comparisons of coal with power developed, but we urge that every piece of machinery should be frequently tested, and records of performance made. When we remember that the entire paraphernalia for a test of evaporation of boilers consists of a barrel, a pair of scales, a thermometer and an intelligent engineer, the simplicity of the work becomes apparent, and when the test once made develops the fact that we are only evaporating six pounds of water, where the boiler manufacturers guarantee 11, the personal advantage of this test is plainly seen in dollars and cents. Many errors creep into the boiler room that are not observed until the test of evaporation stirs up a careful search. Then the boiler settings may be found incorrect, the draft imperfect or not properly regulated, or the firing may be done in such a manner that the coal wasted exceeds the coal used. If this test and the simple test of the amount of steam used in the engine can become more general, the work of this committee can be made more comprehensive, and individual benefits can be derived fully compensating with the work involved.

That our report is not completed and our work finished is partially the fault of the committee. Our circulars asked plain questions which have received careful attention at the hands of the central station men, and replies have been prompt and co-operation all that the committee could desire, but we have failed to show a sufficiently definite object, to sufficiently urge the making of a few simple tests where no records are kept, and to prove conclusively the advantages of the tests to every manager, independent of any organization.

We suggest a continued effort. A growing interest in this work has been awakened, and it is only necessary to make a persistent effort to secure the results hoped for when this work was undertaken.

When the National Electric Light Association all have recorded 2,000 water tube boilers in use in this service, five per cent. of which are evaporating 10 pounds of water per pound of combustible, 10 per cent. evaporating eight pounds and 85 per cent. averaging only six to seven pounds, the importance of this work will be apparent, and when the records of this Association show 4,000 automatic high speed engines in use, guaranteed to deliver one horse-power for one hour with 18 pounds of water or steam, when running condensing, using from this amount to 25 or 30 pounds for this service, the manager will include among the reports from his assistant the date necessary to this work. The time will come when this Association will make these tests for the benefit of its members.

One electric company has found it advantageous to make a thorough test of all the leading steam engines and boilers offered for this service. Our organization offers great advantages over individual or corporate enterprise in this direction. We have almost every type of equipment in use and it only remains to record its performance to make the advantage of membership in this organization as apparent from a purely financial basis as it now is on the basis of education and social enjoyment.

Mr. Burleigh: I move that that report be accepted and the committee continued. Their work is being done right, I think.

Mr. Seely: I second the motion. (Carried.)

The President: I believe there is another section of the report.

Judge Armstrong: I move that that part of the report be continued, and then we can take it up subsequently. (Carried.)

The President: The report of the Committee on World's Fair, Marsden J. Perry, chairman. Are there any members of the World's Fair commission here? If there is no report from that committee, Director-General Davis has sent here as a representative of the World's Fair the secretary of the electrical part of it, Mr. Hornsby. I take pleasure in introducing Mr. Hornsby to you.

Mr. Hornsby: The World's Columbian Exposition was very much pleased at the action taken some time ago by your Association, in the appointment of a Committee on World's Fair. That courtesy is responsible for my presence here to-day as the commissioned officer of the World's Fair, representing especially the electrical department. I will try to explain to you just what is contemplated. The World's Fair is composed of 646 acres, 100 of which is to be under roof. This is the north of the part—this the south. (Points to map.) (Mr. Hornsby then described at some length the different buildings.)

In the discussions of the Classification Committee of the World's Fair a year ago the electrical department was given a group under the department of machinery and assigned to a corner of machinery hall. Its part was inconsiderable and very little was thought of it. The two learned gentlemen who assisted the commission to make the

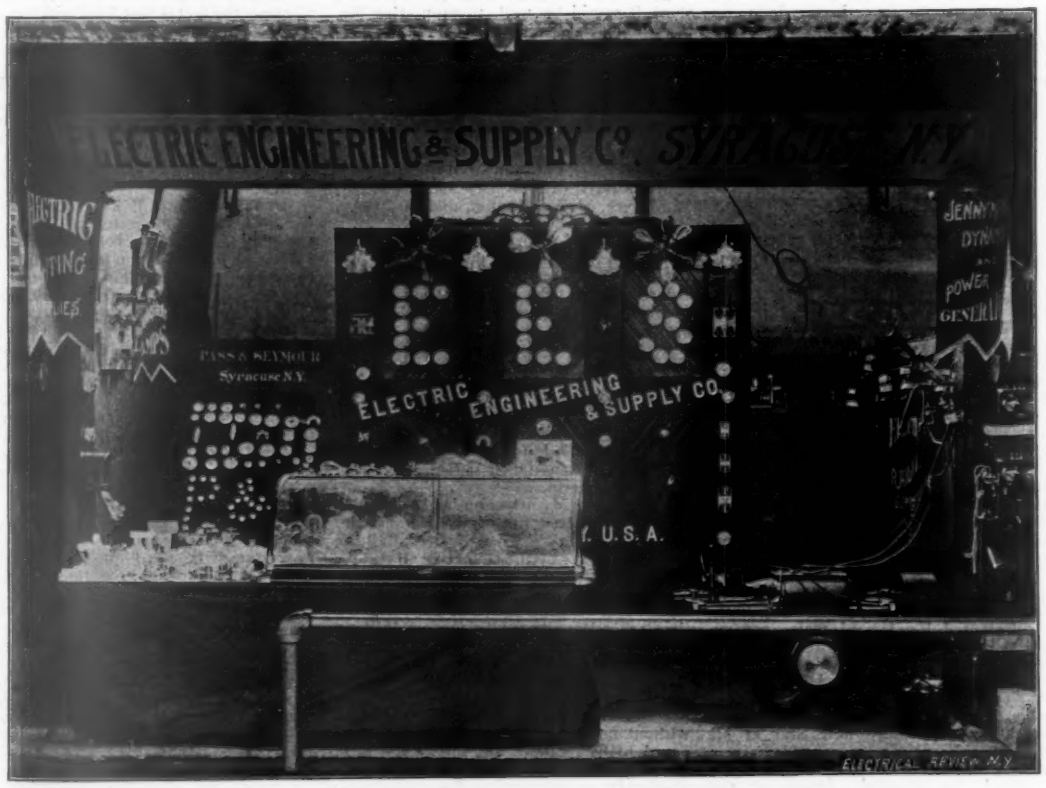

ELECTRIC ENGINEERING & SUPPLY Co. SYRACUSE N.Y.
ELECTRIC ENGINEERING & SUPPLY CO.
PASS & SEYMOUR
Syracuse N.Y.
ELECTRICAL REVIEW N.Y.

FIG. 5.—VIEW OF THE EXHIBIT OF THE ELECTRIC ENGINEERING & SUPPLY COMPANY AT MONTREAL.

classification insisted that electricity was a branch of machinery and as such was entitled only to the consideration of being grouped with machinery. That has been changed. The electricity building is 700 feet long by 350 feet wide, having 240,000 square feet of floor space. It has a 100 foot gallery around the entire extent at an elevation of 38 feet. The roof is 160 feet high, dome shape. It is in the Italian renaissance architecture, under contract to cost $650,000. That is to be purely for the electrical exhibits. The building for the service of the exposition with electricity occupies a larger scope than it did. Electric launches will be here. An electric railway will traverse the entire length of the ground. This is a mile and three-quarters. The road will be three miles or thereabouts long. Electrically propelled elevators will be in all of the buildings. Everything that is done in the shape of power will be by electrical transmission. (Applause.) This will be an expensive plant. The various companies engaged in the supply of power and light will be contracted with to build modern lighting and power stations of their own, after their own plans, to be approved by the exposition management. This will be a 24,000 horse-power plant—a large one, that you gentlemen will know. The distribution from here will be in three directions. From this plant will be served 8,000 arc lamps, 85,000 incandescent lamps, and 4,000 horse-power for the operation of the machinery belonging to exhibitors.

A good deal has been said in regard to the finances of our exposition. You gentlemen are financial people, and I may be pardoned for reading you just a few figures. The resources of the Chicago exposition are as follows:

From stock subscriptions	$5,000,000
From Chicago city bonds authorized by the State	5,000,000
Gate receipts guaranteed	7,000,000
Concessions and privileges	1,000,000
From salvage estimate	3,000,000
Making a total of	$21,000,000

Against these resources are to be drawn amounts as follows:

For ground and buildings	$12,766,000
For administration	3,308,000
For operation, May to November, 1893	1,550,000

Recapitulating, therefore, the exposition company will spend $26,000,000, the United States government, $1,500,000; the States and Territories have already subscribed $5,000,000—two or three special State exhibits. This is not including $5,000,000 which have been subscribed by foreign governments for the maintenance of their exhibits. The South American States alone have subscribed $2,700,000 for their share.

The following nations have already replied to the invitation sent by the United States government: Great Britain, the British Empire, France, Germany, Spain, Japan, China, Mexico, Peru, Honduras, Salvador, Costa Rica, Columbia, Cuba, Guatemala, Jamaica, Nicaragua, Chili, San Domingo, Turkey, Ecuador, Denmark, Russia, Egypt, Morocco, Venezuela, Brazil, Hayti and the Argentine Republic. These are almost what we may expect. It is now 18 months before our exposition opens. We have almost the entire world to draw from already. It is impossible to say how far we may have to go. Since the inauguration of the movement to make an exposition at Chicago it has so developed that the amounts of money already set apart up to a year ago have been found inadequate. Therefore, an extra $5,000,000 is being provided by subscription in Chicago, and a loan of $5,000,000 is being arranged for with the United States government, increasing the resources of the World's Fair to $42,000,000.

So far as we are concerned ourselves, the electrical department has been divided, the services being absolutely separated from the exhibition department. All of the exhibition will be under the superintendence of the Chief of the Department of Electricity. Everything electrical in the exposition will be on exhibition. But this plant here will be purely a service plant, the exhibition feature to be a secondary consideration. It was contemplated originally to install there a service plant proportioned to the good will of the electrical people—free lunch, as some one has been pleased to call it. The management of the exposition thought it would be impossible, on account of the general interest taken in the exposition, to have the electrical people donate for the use of the exposition enough apparatus and enough talent to serve the purposes contemplated. By the hardest work and closest application of the electrical department, we have made it appear advantageously, and certainly for the benefit of the electrical people, that that course would not be in accord with their wishes. Their interest would be dampened if such a procedure were to be inaugurated. Therefore, we have been successful in having this plant installed purely as a business proposition, the idea being to demonstrate unequivocally and in practice the economy of an electrical service over that which was contemplated before—steam and gas. In that far we have been successful, and after the Columbian Exposition I think that we will be able to demonstrate fully all that has been claimed for electricity on the score of economy, comfort and luxury, if you please. (Applause.) Gentlemen, I thank you.

Mr. Francisco: I move you, Mr. President, a vote of thanks be tendered to the secretary of the Columbian Exposition for the full, interesting and explicit explanation and description he has given here of the plans for the Columbian Fair. (Carried.)

Mr. Seely: I move, sir, that you discharge the Committee on the World's Fair and that the chair appoint a new one.

Mr. Hornsby: May I be pardoned one moment, Mr. President. There is one other matter I contemplated speaking about, but neglected. I have been in correspondence for six months or thereabouts with electrical people in all parts of the world relative to the holding in Chicago, in 1893, of an International Electrical Congress. I have arrived at a point in our correspondence and negotiations at which I can say the project is in the way of being successful beyond our highest hopes. We look for the presence in Chicago at that time of the ablest men in the greatest profession now in existence. The Europeans have promised to have their very highest authorities with us. The best of the electrical people of this country are heart and soul with us. The representatives of the societies in this country and in Europe have signified their intention of taking active hold of the matter of holding this International Electrical Congress. A good many of these congresses have been held heretofore, largely in Europe. A good deal of satisfactory work has been done in the settlement of standards, the unification of methods, the revision of nomenclature—all of those things. Very little, however, of that work has been done in this country. It seems to be the feeling among scientific men that we are on the eve of a greater revolution than has taken place in the last few years. The chasm which stands between what we know and what we do not know is deep. It may be unfathomable, and the hidden recesses of nature may not be for our exploring. On the other hand, some man in the vanguard of this work may brush aside the veil that hangs before us and reveal the thing that has been sought so long. The great revolution may be at hand. Why, then, may not this be the time? The bringing together of the Nestors of our science, the concentration of thought, the settlement of methods—all of these things will tend to great good. The standards in the profession can be more fully settled. Unquestionably the nomenclature of the science can be revised at least in some particulars; and to the world in general such a congress as this would do great good. The question has come up whether this should be done through and by the World's Columbian Exposition, or whether it should be done by the various societies. The question should be answered in the affirmative in both instances. It should be done by the societies. They have largely contributed already. It should be done under the auspices of the United States government, which is the authority for holding the World's Columbian Exposition. As the representative of the electrical department, as the accredited commissioner to this convention, I will say that the exposition management stands ready now and at all times to aid such a movement in any way. A provision has been made in the report of the presiding officer of the exposition management which will be read before Congress next Winter with a view to having the government of the United States take official notice of the contemplated electrical congress. The management of the exposition have already acquiesced in the proposition to build a hall for the holding of this congress on the exposition grounds. All of the adjuncts of debate will be present. No money will be spared by the management to make the congress in every way a successful one, and I do hope that at this meeting of this Association—strong, powerful, prominent, representative as it is—that some action should be inaugurated looking to the starting of the ball which shall roll to be a gigantic one. Something should be developed at this time that would give us a nucleus around which to work. In the course of time the other societies will take their part. The Electrical Engineers, I understand, have gone far already, and with the help of such societies as these, we have no question about farthering a proposition to hold an International Electrical Congress. (Applause.)

Mr. T. C. Martin: Mr. Hornsby, in his remarks, has made reference to the work of the American Institute of Electrical Engineers in connection with this congress, and I think I may briefly state what has been done, and then if you will allow me, suggest that this Association act upon somewhat similar lines. Two and a half years ago, at least, at any rate before it was known that the World's Fair would go to Chicago, and when some of us still fondly hoped that it would not, the American Institute of Electrical Engineers, taking time by the forelock, appointed a committee to secure the holding of an electrical congress or conference in this country. A congress was then about to be held in France, at Paris, at the exposition, and we sent delegates to that congress. Those delegates—some of our most prominent electrical engineers and inventors, among them being Mr. Edison, Prof. Elihu Thomson and others of that rank—extended in the name of the institute to the delegates to that electrical congress an invitation to attend such a congress in this country during the Columbian Fair year. The invitation was received and accepted. During the present year another congress of like nature is being held at Frankfort in Germany. That congress in France was held under the auspices, first, of the French government and of the exposition authorities, and secondly, under the auspices of the French Society. A similar procedure prevails at the present time in Germany with regard to the conference there, and it is being held under the auspices of the government and with the direct support and aid of the German Society. Now, I think that Mr. Hornsby has outlined to us just such a line of action for work in this country. It is proposed on the part of the institute, and when I say that I speak as secretary of the committee which has the work in hand, to work as far as lies in our power with the World's Fair authorities, and we think that with the assistance and co-operation of such powerful bodies as this, the congress that is held in Chicago in 1893 will not only be the most memorable, but the most useful of all the congresses that have been held up to date, and, as a member of this Association, I think it would be well, in supporting Mr. Seely's motion, to have a committee appointed that will work, that will permit this Association unreservedly to the support of the World's Fair, and to make the movement in Chicago and the congress a success (applause).

(The motion of Mr. Seely was carried.)

The President: The chair will appoint as such committee, Mr. B. E. Sunny, of Chicago; Mr. S. G. Coleman, of Milwaukee; Mr. Maurice Hart, of New Orleans; Mr. Fred. W. Royce, of Washington, and Mr. Chas. W. Price, of New York.

The electrical report of the Committee on Data, I believe, is now in order. If Mr. Peck has the report he will kindly read it.

Mr. Peck: As the report of the electrical section of the Committee on Data, I wish to present this form by which to record data concerning street lights. (Form was then exhibited.)

Judge Armstrong: I move that it be received and adopted.

Mr. Burleigh: And that the Secretary of our Association refer it to the Census Department, at Washington, with the request that they so arrange their statistics as to conform to that form.

Mr. Weeks: My attention has been called to a clipping from one of the Kansas City papers regarding the price of street lighting in various cities of the country, and I take it that if data are to have any value whatever they should be accurate, and I am very sorry to see that the data that are given by the Census Department in Census Bulletin No. 100, referred to in this article, are not accurate. For instance, the statement is made that in San Francisco the price is $440.67 for one arc lamp for one year and in Denver $58.46. Those statements are made simply without any qualification whatever. I happened to be familiar with the facts in both cases, and I know there is no foundation—absolutely no foundation for those statements; and I think that it is but just to our good friends Rollins, of Denver, and Roe, of San Francisco—than whom there are no fairer minded and juster men in the fraternity—that that statement be corrected. The facts are that in San Francisco, where, it should be remembered, coal is $7 a ton, the highest price paid for any one lamp per year is $361.90, and that is a 4,000 candle power lamp, maintained at a point remote from the central station, with a considerable mileage of circuit in order to reach that point, of course, and, instead of being so generous as one would infer Brother Rollins has been in Denver, to give them an arc lamp for $58.46, his good business sense has led him to do quite otherwise. The rate that he gets there is $150 within a certain radius and $216 outside and for tower lighting—two very different propositions. In this connection I want to call attention to the amendment that was suggested by the committee to the scheme proposed by Mr. Foote, that a very important factor in this whole matter—one of the most important factors—is the question of distribution. I have had occasion to look into this matter quite extensively of late, and I find that the distribution of municipal lights ranges all the way from eight and six-tenths lamps per mile of line down to one lamp per mile of line. Any electrical engineer will at once appreciate the importance of this, and that element should always be included when a comparison of prices is made. Of course, there are other elements that occur to almost every one—the system used, the watts consumed, the period of contract, the price of coal, whether it be water power or natural gas—but the mileage of circuit per lamp seems to have been generally overlooked. It is important in two ways—first, it determines the amount of investment. I find in the cities that I have looked up that the investment per lamp in street systems ranges from $35.87 to $190.40. You can readily see that when it comes to operation it will be still more important, as not only has the resistance of the line to be overcome, but it has to be controlled and maintained, and your trimmers have to traverse all of this distance. I want to say that I think that Mr. Foote, in the schedule proposed, has covered the ground very thoroughly, with the amendment suggested by the committee. I hope that he will find that it will be readily filled out by the central station men.

Mr. Francisco: There are so many factors that enter into the question of cost that it is utterly impossible, without some such information as we can get from this census matter, to tell anything about the matter in any way, shape or manner. You will often see published in the newspapers and magazines, statements of the cost of street lighting in different places. They will give the cost in Boston, where steam power is used and coal is $5.50 per ton, and compare that with the cost in some place in the West, where water power is used and no coal is required, and where they are burning in one place 1,000 lights and in another 50 lights. In one article which I read I saw the statement published that Boston had to pay $180 per year, while Ypsilanti only paid $13. That would carry the idea that the citizens of Boston were being outrageously swindled, whereas, the fact is that Ypsilanti uses water power, while Boston uses steam power. You cannot make a good comparison of those things without you have such facts before you. These statistics that Mr. Foote will furnish may cover that very ground, and will show up all these different points, so that you may make a comparison and make it intelligently. I trust, therefore, that this matter will be thoroughly carried forward.

Mr. Foote: You all know that this subject is one which interested me before I had anything to do with the census. Mr. Weeks has called your attention to some things that the census office has done that on the surface presentation seemed to be hurtful. I took a little consolation out of those figures, thinking that if they hurt you pretty badly it would show the necessity of giving correct data on my schedule so that I could make a report which would help you out of the hole. I have prepared a schedule that contains a number of points of inquiry. I submitted that schedule to 37 managers of companies, every one of whom when they first took up the outline commenced by the wise remark, "cut it down." The net cutting down made by the 37 managers was an increase of five points. The outline for street lighting reports that has been submitted to you can be filled out from the information to be obtained by those schedules, provided we get the information on the schedules. Mr. Weeks calls my attention to the fact that he wanted a mile of circuit included, but I cannot make a report on a mile of circuit unless you give the mile of circuit on your reports to me. Some of you may think it strange, but the fact is that a great many central station companies do not know anything about the mileage of the circuit. Knowing how difficult these things were to reach, and knowing the necessity, the supreme importance, of having these figures correct when published, I have induced the superintendent of the census to appoint Mr. Foster as a special agent to visit central stations in the State of New York, go over the schedules with them, correct and verify their statements, and lend his assistance to them in filling out those schedules, so that I may feel when I have the figures for tabulation, that I have something which is *bona fide*, something which is reliable, and which can be accepted as an authority by the people of this country on that question. That work will be pushed to completion as rapidly as it can be done, and I hope that every man that Mr. Foster may call upon will see the importance of laying aside his business for the hour and giving Mr. Foster the time, so as not to hinder him in his movements, but let him complete the work as soon as possible. I believe it is possible now with the opportunity that we have to so formulate a report for street lighting, contracts and prices, that it will forever wipe out these wrong figures, commencing with the highest priced lamp found in the country and ending with the lowest priced lamp, with no details given to show why one is high and the other low. The more I have had to do with this problem of data and statistics the more conservative I get, and the more afraid I am of making any statement whatever with figures. My friend, Mr. Tiffany, who published that bulletin, started out on the theory that he must ascertain the number of miles of street in a town, and the number of lamp-posts in a town, and he simply passed every post that had a lamp on it as one lamp, as he unfortunately called it. He ought to have called it one

post, and then it would have been all right, but he made no discrimination between an eight foot gas burner on a post, a kerosene lamp on a post, and a tower of 2,000 arc lamps on it. He counted them all as one post, and his schedule is worked out upon that theory. I think you will find, if you have the necessary patience for this work to be done (and it takes time to do it), you will get a report that will absolutely relieve you from all the difficulties you have been under in meeting these figures as to the cost of public lighting. That we will give you as soon as possible—having the two features always in reserve: First, that you give me the figures that are correct, and secondly, that the Census Office give me a sufficient amount of clerical help to do the work—both of which are very necessary things. What we want to have is figures that will not lie, and in order to have those we must have figurers who will do correct work. (Applause.) (Motion carried.)

Mr. Armstrong: The Committee on Legislation has no report to make. The design of that committee was that the members from each State would give the matters of legislation occurring within his jurisdiction to the chairman of the committee, so that it could be formulated and submitted here, a splendid scheme, but unfortunately it has not worked at all. In my own State (New Jersey) the legislature was so busy with political matters, fortunately, as to leave us almost entirely alone, and I think that is about all that we need to ask in the way of legislation, to be left alone. I believe that the usual number of underground bills were introduced, and I think that one bill which I referred to at the last convention—about getting away up in the air, some 200 or 300 feet—was also introduced, but nothing came of any of those measures. And so, reporting for that committee, I can only report for New Jersey.

Mr. Wilmerding: In Illinois, at the last session of the legislature, there were a great many bills introduced with a view to knocking out our interests. One bill was the one referred to by Mr. Francisco, by which the cities and towns were authorized to carry on a commercial lighting business, not only with electricity, but with gas. That bill died in the committee. There was another bill introduced to the effect that no wire would be operated in the State carrying a voltage of more than 1,000 volts. That also died in the committee. We were fortunate in having one or two friends in the legislature who had influence enough to knock out those things. Of course, we have all got to look for such action. I suppose it is sandbagging, but they did not make much out of it, and perhaps next time they will not attempt it.

Mr. Francisco: As a member of the committee from Vermont, I will say that our legislature only meets once in two years, and therein we are fortunate. We have had no session since the last meeting.

The President: In the absence of Mr. Maher, who is the member of the committee from New York State, I will say that each year in New York we have had a bill up (we had one Winter before last, and there is one down there now), but, as is usually the case in New York city, the tail was trying to wag the dog. In other words, the members of their electrical commission in New York city are getting a good fat salary, and they want to nurse that thing as long as they can. The bill contemplated would wipe them out. So we have got them fighting amongst themselves, and the result is that nothing has been done in New York State, and we are liable not to have anything done. The coming Winter I presume that the same thing will be up, as I know of a gentleman who is a very hot candidate for one of the commissions, but I have no doubt, that some of Mr. Seely's friends—Mr. Jake Hess or Mr. Theodore Moss, or some other one over there—will be as anxious to retain their positions as they were last Winter.

Mr. Bell: I would like to ask, partly as a matter of information, and partly as bearing upon a subject that might develop into something interesting, and as relating to a subject in which I feel a considerable interest—as I have had my attention called to it in one way or another in the light of these obnoxious bills—I would like to inquire whether there has ever been any systematic attempt to find out the nigger in the fence in this business? In other words, whether a majority of these bills emanate from cranks, from quasi socialists, from previous competitors, or from what source? Sometimes a little information as to just what is being worked to further a particular bill might be very useful in assisting various members of the Association in meeting such measures.

Mr. Armstrong: If the stenographer will not report what I say, I think I may answer Dr. Bell's inquiry. * * *

Mr. Scott: In Pennsylvania we have carefully watched the legislation, and we have tried to have everything avoided that was inimical to our interests, but there has been a bill passed at the last session which directly strikes at and affects their interests, and which should not have been passed at all, and could not have been passed (for there was no money in it) but for the determined efforts upon the part of its promoters to have the bill passed. That was a bill in relation to the cutting of trees. It is a most iniquitous piece of legislation, so far as we are concerned. It provides about in this way: That any citizen, any person in any borough, township, or in any city of the first or second class, who has knowledge of the cutting or trimming of any tree along or upon any highway, or the branches of trees upon private property, which protrude over the highway, by any telegraph, telephone or electric light company, and who shall lodge proper information, that thereupon the Court of Common Pleas shall appoint a jury of view, and that jury of view shall proceed to assess damages and costs upon such telegraph, telephone or electric light company. There was an influence brought to bear in favor of that bill which could not be overcome. Some of us took the trouble to contest it, and found that the Suburban Electric Light Company, of Philadelphia—a county company—had asked the Land Association along their route for the privilege of cutting trees. They went to the secretary's office and asked for this privilege, and he said, "Yes, you can cut all that you want to," meaning just to cover the right of way outside of their fence. But that company went to work and cut trees down that were inside of the fences. Any one traveling from Philadelphia to New York can see for over half a mile the fine trees lying right there on the road alongside the railroad track along the State road from Philadelphia to Trenton. Well, it was a bad thing to do (laughter), and the Land Association, which is composed of politicians of Philadelphia, who can carry any measure through the legislature, decided at once that they would stop that business, and so they put this bill through. So that it is not merely the aggrieved property owner or anybody who may have any particular interest in the matter, but any tramp who comes along the road may lodge an information before the Court of Common Pleas, and then the damages have got to be assessed. Those things ought to be looked into.

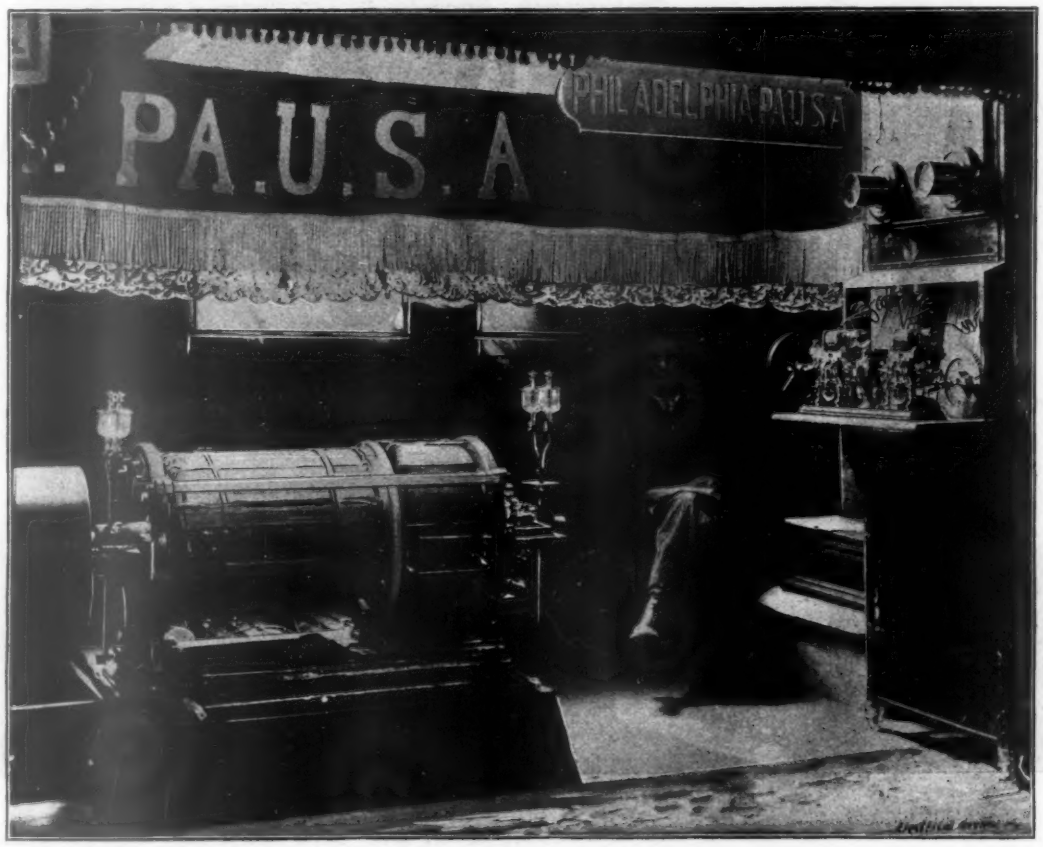


FIG. 6.—VIEW OF THE HEISLER ELECTRIC COMPANY'S EXHIBIT AT MONTREAL.

There is another matter of legislation we have tried to accomplish in Pennsylvania. It is understood by every one who has had interest enough to look the matter up that gas and water companies have an exclusive right—such an exclusive right that electric light companies cannot get in. Now, there is no more reason why an electric light company starting in a small town, like our own town of Bristol, of 8,000 inhabitants, against a gas company which has been running since 1856, and has been paying 8 or 10 per cent. dividend right along—there is no reason why that gas company should have exclusive charge, whereas, an electric light company, after having invested 20 or 30 thousand dollars in their plant, and have finally got the thing running, should be compelled to buck against any one who may choose to come in and make a competition. Those matters can be arranged in time, but, of course, it may take a long time, and it will require a great deal of trouble and effort on the part of somebody. We can do a thing of that kind in a better way than by the use of money. We can accomplish what we wish by argument. If you will just show the people who are interested in the corporation—your own stockholders, the men who have put their stamps down for the purpose of carrying on that business, that there is something that they have got to look out for, that just as soon as you begin to make eight or ten per cent. and to accumulate a surplus, the gas company or the water company in their own town, using the power which they can apply to that purpose, can run a pole line right along the side of us, and can take our customers right away by cutting our rates—that they can do this because they have an exclusive charter, whereas, we cannot go in and manufacture gas, or put water through the streets as they can do! I say, that if you make your stockholders understand this, you may accomplish much. There are a great many of these questions that come up in this country, and that ought to be looked after, not only by the Committee on Legislation, but ought to be the business of every man connected with a central station company, from officers to stockholders, to look out in this way for his pocketbook. (Applause.)

Mr. Bell: There is one further suggestion, with regard to the matter of legislation, that I would like to bring before the Association; more, perhaps, for the purpose of getting the facts about it than for the sake of suggesting any possible remedy, because it would require careful study to do that, and that is the existence of the fake electric light companies—companies existing on paper, with a board of stockholders, usually composed of the stockholders of the gas company, holding meetings once a year, if it is absolutely required by law, and existing simply for the purpose of stopping legitimate electrical enterprises.

Mr. Seely: I move that the report of the committee be received and that the committee be continued. (Carried.)

The President: Next in order is the report of the Committee on Underground Conduits and Conductors, of which Mr. Francisco is chairman.

Mr. Francisco: In behalf of the Committee on Conduits, I have to say that we have undertaken quite a task. We found that the subject of underground conduits was one that was liable to involve quite a study in relation to a great many statistics and a great many points. We went to work to get at the bottom—to get at the facts. We have collected a good deal of information in regard to that matter, but the time has been so short that we confess that it has been impossible to get all the matter that we had prepared to report on ready at this meeting. I have been in correspondence with parties in London with regard to the entire underground conduit business of London, but the report that I expected to have here to-day has not yet arrived, on account of the time being so short in which to get the correspondence back and forth. The same statement is true with regard to several places in the United States. Therefore, we did not feel like making a report which contained merely a partial statement of facts, because, as several central station companies had stated to me that they do not want anything but facts, and that they want to base their calculations upon what we find to be facts with regard to what they are going to do. The position that I have taken, and that the committee took, is that if there is a system of underground wiring that is practicable and proper, we want to find out what is the best system and then leave those that want to adopt it upon the information which we may obtain, to decide as to which is the best, the most practicable and the most serviceable. We cannot get the information and come to that decision in the time allotted for making our report at this meeting. Therefore, we shall have to ask the convention to extend the time, if they want the information.

(On motion of Mr. Armstrong, seconded by Mr. Weeks, the committee were continued, and requested to report at the next meeting.)

The President: We will now hear the report of the Committee on Safe Wiring, of which Mr. DeCamp is chairman.

Mr. Armstrong: Mr. T. Carpenter Smith had this report, but as he was feeling quite unwell indeed, he asked me to read it for him. (Report as adopted appears on page 55).

Mr. Peck: I move that the report of the committee be received, and that the secretary be authorized to print the same at once, and present copies of it to the members of the Association.

(After some debate, it was voted to have the report printed as soon as practicable.)

The President: The order of business for to-day has now been completed. I will state that all of the papers, with the exception of Mr. Warner's and of Capt. Eugene Griffin, are in the hands of the secretary, and members can procure copies of those at any time upon application to him. The order of business will have to be changed somewhat, under the direction of the executive committee, owing to the fact that we cannot get those two papers out of the hands of the printer for use to-morrow morning, but all the other papers are in pamphlet form and can be procured of the secretary.

I am requested by Prof. Bovey to say that inasmuch as there has been some friction and perhaps some shortcomings in sending out the invitations to the garden party and the reception at McGill University this evening, that any and all members of the Association are very cordially invited to attend. He wished to say that he would be very glad

if every one would avail himself of the invitation to meet at McGill University, whether he has received cards or not. I will ask the members to take it upon themselves to inform those who are not here this morning that they can obtain cards at the secretary's office at the close of this session.

Mr. Weeks: I think it is proper, before we adjourn, to call your attention to Article V. of our constitution, which reads: "The annual meeting of this Association shall be held in February, and a semi-annual meeting may be held in August in each year, at such place as the Association shall determine, on such days as may be determined by the executive committee;" and to remind you that by changing the date of this semi-annual meeting our constitution has been violated. I think that it is proper to make this mention, and in making it I want to be understood as fully appreciating and as being fully appreciative of the kind hospitalities of the people of Montreal and Canada. I want also to say that I think I have some adequate comprehension of the indefatigable labors and self-sacrifices that have been made by our President and by the officers of this Association in preparing for this convention. But I do think that the matter of taking liberties with the constitution is of sufficient moment to require this remark. For that article of the constitution there was a very good reason, and it was this: That during the month of August the central station men of the country could best afford to leave their business and attend the conventions of this Association. Many to whom I spoke personally regarding this convention said that they could not attend for the reason that it came so late. While I have the fullest appreciation of the right royal reception which has been given us by this right royal city, I do protest against the National Electric Light Association, which is a business organization, being misdirected and made solely, or apparently solely, a social or a political organization, or its convention being made to mark an international incident.

Mr. Seely: As one of the executive committee, I plead guilty to an apparent violation of the constitution in agreeing to postpone this meeting. But, the constitution says, that the annual meetings of this Association *shall* be held in February and that semi-annual meetings *may* be held in August in each year, at such places as the Association shall determine, and on such days as may be determined by the executive committee. I believe that the Association agreed at Providence to hold a convention here in this city. The date was fixed for some week in the latter part of August, but the hotel people notified us when we had about made all our arrangements, that they could not possibly accommodate us at that time, so that it was either a question of adjourning this meeting entirely, or a question of postponing it one week later. It is a pretty hard matter to assemble the executive committee of this Association in New York city. It costs money to travel, and as they are pretty broadly scattered over the universe, only a few members can be got together to hold the small routines and to do what we think and deem is best for the Association. I believe that the secretary notified every member of this Association, and there were no objections made by members of this Association to holding the convention here in Montreal, and they had ample time to appeal to the executive committee. I do not care to go any further into details.

Mr. Armstrong: I understand, Mr. President, that the minutes of this meeting will read to this effect: That a convention properly assembled the last week in August and there not being a quorum, adjourned until yesterday, when it was formally opened. We often have to do that. If the minutes are right, who is going to impugn them? We, unfortunately, had only one member in Montreal during that week, but still we did have one member here, and one member can adjourn a meeting to another time.

The President: Perhaps it is due from me, as the president of the organization, to say something on this subject, although Mr. Seely has gone over the ground very fully. As he has said, the hotel accommodations were not to be had during the month of August. Our very enthusiastic friend and member, Mr. Corriveau, was not thoroughly advised when he extended the invitation to come here in August. At that time we knew as well as anybody could that we were violating the constitution. But, after coming here, going over the ground, seeing these people, knowing all of the conditions in Montreal, the members of the executive committee said, we will take it upon ourselves, whether it be right or wrong, believing that in so doing we will have best served the interests of the Association. We are in Montreal to-day. We have got a convention. We have got an exhibit. And if there is a central station man in the United States who could not have spared one day to come here and listen to the report of the committee of which Mr. Brophy, Mr. Law and others are members, and the other papers which will be read here, then I must say that he has not the interest of the Association at heart one single bit. It may be due to you, as your president, to apologize for the postponement of this convention. If it is necessary to do that I can eat very humble pie. But I think that our work will speak for itself. With that I will say no more. (Applause).

On motion, the Association then adjourned to Wednesday, September 9, 1891, at 10 A.M.

Third Session—Wednesday, Sept. 9.

The convention was called to order at 10.20 A. M.

The President: I am in receipt of the following letter from the Canadian Pacific Railway Company, dated Montreal, September 8:

I beg to offer through you, to the members of the Electrical Convention, free telegraph privileges for social messages during your stay in Canada, over the Canadian Pacific Railway Company's telegraph, and I am also authorized by Mr. A. B. Chandler, the President of the Postal Telegraph Company, of New York, to extend similar privileges over his telegraph system. Yours truly, CHARLES R. HOSMER, Manager C. P. R. Tel. Co.

I am also requested by Sir Donald A. Smith to extend an invitation to the members of the Association and their friends —and he wishes me to emphasize their friends—to visit him to-morrow afternoon at his home from 4 until 6.30 P. M. The citizens' committee have arranged a trip down the Lachine Rapids. In the original programme it was designed to stop at the Indian village on the opposite side, but that will be abandoned. We will be back in ample time to accept the hospitality of Sir Donald Smith at four o'clock. I hope the gentlemen will all be there, for I am sure it will be a very interesting and pleasant occasion.

Mr. Stiness: I move that the thanks of the Association be tendered to Mr. Hosmer and Sir Donald A. Smith. (Carried.)

The President: The first regular business of to-day is the discussion on the distribution and care of alternating currents, the subject of the paper read by Mr. T. Carpenter Smith, at Providence. To facilitate matters we will not read the paper now, but inasmuch as all of you have copies of it, it is now open for discussion.

Mr. Law: I most heartily endorse what Mr. Smith says of the short-sighted policy of the majority of electric light managers in putting up cheap insulation; in other words, the principal point of success in alternating works may be stated in one word—"insulation"—for on alternating wires a short circuit or ground means, as a rule, a burnt-out armature. For I find that in most of the cases the dynamo man gets tired of renewing the fuses at the generator, and will put in a 160 or 200 ampere fuse on a machine that is only adapted to carry 130 amperes. I find that the better plan is on a 130 ampere machine to put in a 135 to 140 ampere fuse and then change it often, not waiting for it to burn out, but change it and put in a new one. By doing this you keep the machine fused very close to its carrying capacity, and the fuse will then go before the armature will become overheated.

There is the greatest of danger in not having the primary wire fused before reaching the converter, although there is a remarkably small number of burn-outs in converters, yet when it does occur there is a danger of the primary wires becoming connected with the secondary and you have a 1,000 volt current at your lamps. All converters are so built that a contact between primary and secondary coils is almost impossible, but if by a short circuit in your primary it receives a current of from 50 to 100 amperes, when it is only adapted to carry from one to five amperes, thus causing it to overheat to such an extent that it will burn any insulation which may be used. This is very liable to cross the primary and secondary wires, and you have all the dangers of a high electromotive force clear to your lamp socket. Properly fusing the primary wires will effectually prevent all this danger. One weak point I find in alternating central station construction is the double-throw switches; they are never large enough to break the arc, which they are sometimes required to do, for it is not only to break the usual load of from 50 to 75 amperes on each circuit, but in case of a short circuit or ground it may reach three or four times that amount, and the fire and noise produced in a break of that kind is only realized by those who actually perform the operation. Likewise the fuses are not one-half large enough to break radially. These fuses are generally placed on the back of a wooden switchboard, and are a great source of danger from fire. (Applause.)

The President: I trust that the gentlemen will remember that this paper is a very important one, and was so considered at the Providence convention; so much so that it was the first paper in the history of the convention that was left for discussion at another convention, and there ought to be a great many of our members able to say something on this paper, and I should regret it very much if there was not a very generous discussion of it by nearly every member that is here. It is one of the most practical papers which has been read before the convention. It affects, I think, every member of the convention.

Mr. Francisco: In the work in which I have been engaged for the last six months with regard to this underground business, I have had a chance to meet this point of overhead and underground construction very generally, and my experience is that one-half of the trouble we have had in regard to underground and overhead work has been from the loose, miserable manner in which the overhead wires were put up. If the electric light companies themselves had thoroughly installed their system and run their wires in a proper manner, spending, perhaps, what they have for underground work, we would not have had one-half of the trouble we have at the present time. In several cities I have visited in regard to this underground business, the officials themselves have said, "Why, if you people would put your wires overhead in proper shape we would not have commenced this raid. But here are these wires strung in a slip-shod, hap-hazard manner, without any system or care, and, in many cases, without any real insulation, and, of course, we have to protect the public. We are here as officials to protect the public, and, naturally, if you people will not take the initiatory steps to protect the public, we have got to compel you."

There is one other point here that Mr. Smith speaks of in regard to lights running on contract or meter. The human family are very peculiarly constructed, and my experience in electrical lighting business has been that a man who wanted light 24 hours in the day right through when he made his contract, never expected to use that light more than an hour and a half or two hours during those 24 hours. That was the universal basis upon which he made his contract. There was no occasion whatever for the light more than two hours. No matter how close you bring your contract down, no matter how many patrols you run around, it does not make any difference. I have myself passed the establishments of men to whom I was furnishing light under contract for a certain number of hours. I have passed their places four or five hours after the time expired for their lights to be extinguished and the lights would all be going. On one occasion I walked into a man's establishment and the lights were burning. I looked around the establishment. He had the whole place illuminated. He said, "Is anything the matter?" I said "No, nothing at all. I wanted to see how those lights were burning. They seem to be running very fine." He looked at me and he happened to think that, perhaps, it was after the time that they should be running. "Well," he said, "I happened to step in here to-night to turn them off." The next night I passed there at the same hour and he happened to step in and turn them off. I followed that up for about a week, and I noticed he happened in there every night, and he stayed there every night until 12 o'clock. Of course, if you charge that man for extra hours you would have trouble at once. But with this meter on you can tell the man distinctly: "You may burn as many hours as you please; you simply pay for what you use, and that is all there is of it." That is the true basis of all electric light business,

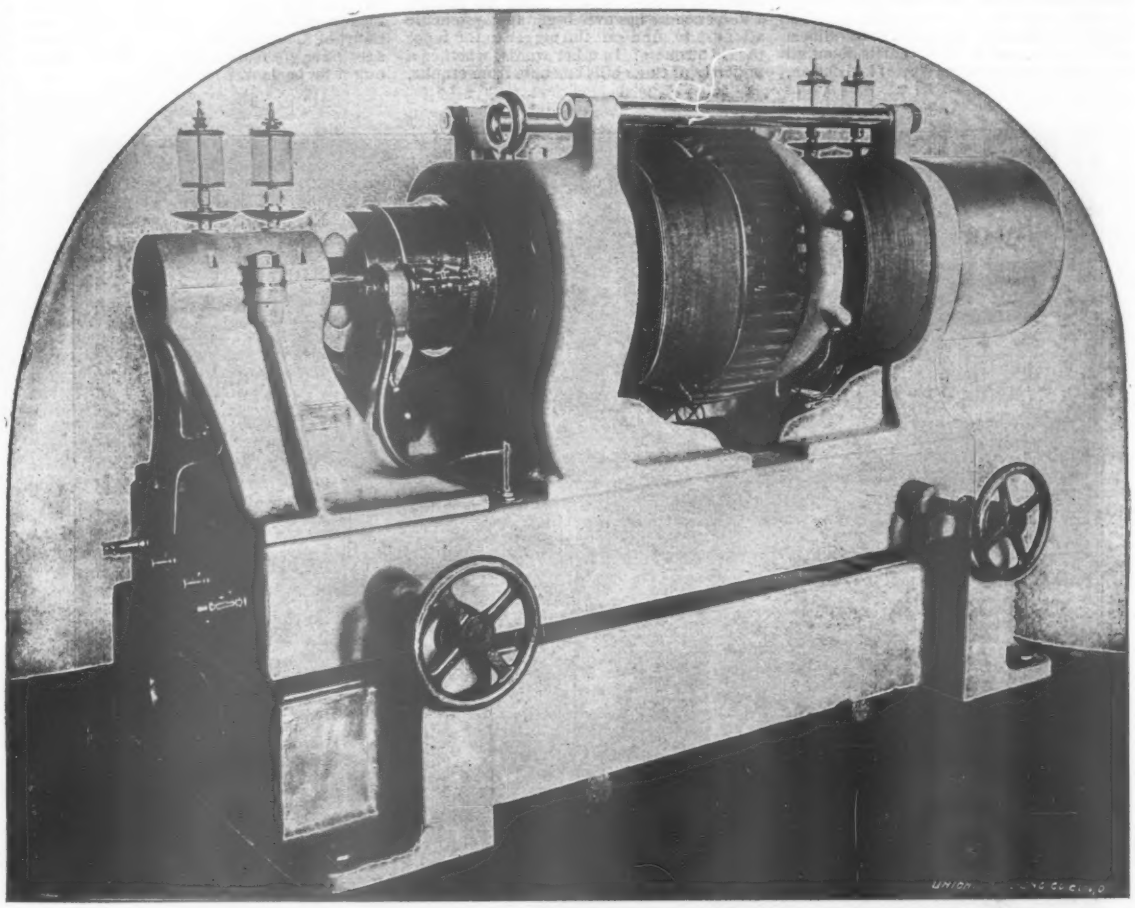


FIG. 1.—NEW BRUSH APPARATUS.—(See page 64.)

I think. A gentleman got up—I think it was Mr. Law—and mentioned a point in regard to some matter. I had just entered upon the very work that he stated to be utterly out of place—that could not be carried out and a thing that would be a loss to anybody who attempted it. Immediately after that I went right to the telegraph office and telegraphed to the man to stop work on that thing, and when I got home, I said, we will abandon that. I saved several hundred dollars by that operation. I got it here by Mr. Law's suggestion of a little point. If all the central station men would come here and bring these practical papers before us, they would find it would save them hundreds of dollars, and that is just what this Association is for. (Applause).

Mr. Law: I will state a little circumstance respecting one of the methods of keeping the meters. The man had pried up the cover of the meter sufficiently to introduce three or four spiders. A few spider webs in there were all that was necessary to retard the meter. I traced this matter down and found that he actually pried up the cover and introduced the spiders.

Mr. Francisco: Mr. Law's little remark on that reminds me of a thing that occurred the other day in my experience. I found that this plan of prying up the meter was adopted. I applied a small wire so that when he pried up the meter and had a short circuit he never repeated it.

Mr. Ayer: In Mr. Smith's paper I see no primary, in some cases, for large buildings, we put cut-outs on the pole and still kept the fuses in the primary end. But we had very little trouble with the primary fuse except in the case of short circuits, in which case the primary fuse always went. We never had any trouble with a short circuit from the blowing of the primary fuse, but I believe others have had that trouble—with the primary terminals being so close together when the fuse blow the lead vapor will not cross. There are converters now made in which the primary fuses are put on a separate plug, and that plug is pushed in and can be taken out and the fuses replaced without touching any high tension wires or connections with the current on. That has another value, and that is that the fuses, if required, can be soldered into the plug and spare plugs can be kept on hand, while a lineman can go around once a week or a month, or as often as is thought necessary, and by working the plugs he keeps the contact clean and works off any corrosion that may be in there, and keeps a great deal of heat out of the fuses. That form of connection I spoke of—about having some arrangement made by which a fuse on the feeder should be on a switch, so that the switch could be worked for keeping the contacts clean without cutting the current off—that is a point we have to keep clearly before us—that incandescent light to succeed must be as continuous as gas, and while a customer will not object that the installers of transformer systems were really cutting their own heads off by increasing this danger themselves. I found, frequently, wires in the primary and secondary side of the transformer, instead of the fuse—not in one case but in hundreds of cases. The cause of this was the electrolytic action that takes place in the transformer which causes the fuses to give way.

Mr. Scott: About two years ago we had one converter that was persistently blowing its fuse. I told the lineman to bring it to the station. The base under the screw head of the fuse connection showed a mark indicating that the fuse had melted there. The screw had become loose either by the swaying of the pole or the humming of the converter, I never have been able to determine which. The vibration of the screw had formed an arc which had melted that fuse. The brass had become red hot, and the switchboard below it was completely charred for about half an inch behind it, so that the screw and its base were ready to fall through. After that we made our lineman go through every 30 days and examine our fuses. With secondary fuses I never have known of an accident to one blowing during a thunder storm. Sometimes a whole loop of 18 or 20 converters will have their primaries blow. People are tempted to get small sizes on account of economy and place them on a line where they have three or four lights to supply. For instance, a five-light converter will be put up. The lineman comes along

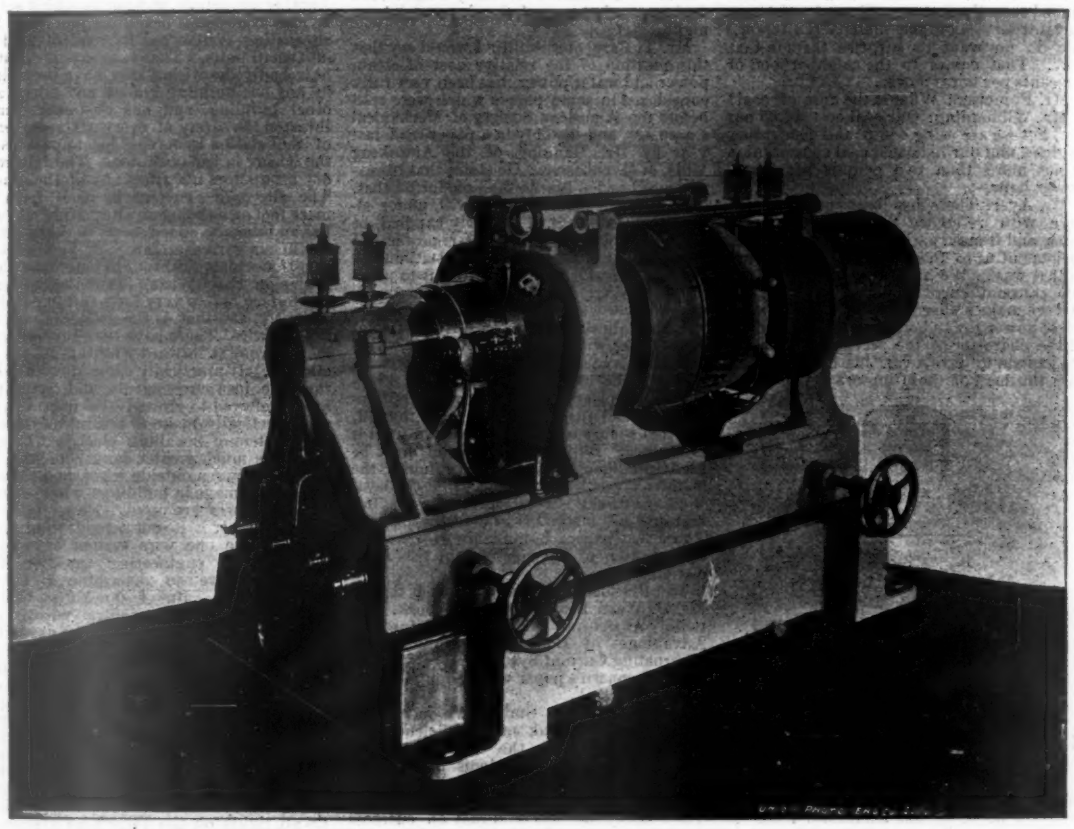


FIG. 2.—NEW BRUSH APPARATUS.—(See page 64.)

allusion to a thing that seems to me a question as to the location of the cut-out on the fuse. Some of the manufacturers take the position that those things should be separate and independent of the converter and left on the outside and should not be incorporated in the converter box. We know that the practice with others is to put them in. I am particularly interested in the experience of those who have had it both ways, because I am about to add a large incandescent alternating plant department to the station, and I have not had this experience with them. It seems to me it is a matter well worth taking up, because there is a very decided stand taken upon it by different manufacturers and I would like to raise that question.

Mr. T. Carpenter Smith: I would say, with regard to the placing of fuses in converters, that our experience has been that, as a rule, there is little trouble with the primary fuse in the converter, except when you want to replace it. It is usually a very ugly job to replace a primary fuse in a converter. We have for a good while now left the secondary fuses out and we have always followed the practice of putting a cut-out immediately at the converter, but on the outside of the converter, and we found that we had a great deal of trouble with the secondary fuses, from the fact that it is a heavy fuse and the contacts are not large enough. It is difficult to get contacts that will last three or four months without being corroded. We, therefore, put copper in those fuses and depended entirely on the cut-out, which is immediately outside the converter. On the to a wink in his light, he will very strongly object to the light being out for four or five seconds. If the light merely winks on the changing of a switch, he looks up and the light is steady again and he thinks, perhaps, he was mistaken, and he does not take any further notice of it. But in a large house, where large quantities of goods are handled, it is very awkward to have the light stop four or five seconds.

Mr. Ayer: The point that I want to get at is leaving the cut-out and fuse outside the converter box. It perhaps has some value in a short circuit coming on the loop. Bringing about a short circuit will only blow the fuse which is placed in the cut-out of the pole, where, in the event of the cut-out being incorporated in the converter box, the primary fuse, in that case, would undoubtedly blow a fuse in the main feeder, also leaving a dangerous condition of affairs on the wires. The cost of construction is very much greater where the separate box is used, and it is a question whether it is desirable, of course, to obviate this danger of short circuiting on the loop. The converters may be placed on the pole, and there is room for cut-outs. That would place the fuse at the point where it would be protection to the public as well as to the feeders.

Captain Brophy: I had a little occasion to look after the installation of electric light wires, and I found that while one party was endeavoring to convince the public that the alternating system was a menace to their lives and property, those who were installing contended for the opposite. I found and finds that the fuse wants attention. He has a ten ampere fuse in his pocket and he puts it in. During a thunder storm, the lightning or the static electricity on that line attacks that converter, and it finds it easier to burn out that No. 20 or 22 wire then to burn the ten ampere fuse. Consequently, the primary coil is gone and the converter has to be taken down.

Mr. Baxter: I quite agree with Mr. Francisco in thinking that the trouble that we have had has been due to bringing in a class of consumers who have a large number of lights with very small usage. As you all know, there is a certain amount of leakage in all converters, and where a man in a residence installs 100 sixteen candle-power lamps, and uses, perhaps, but 10 or 12 of them for two or three hours each evening, the profit is entirely absorbed in the energy which is used up in the leakage, and some system should be devised so that the man in charge of the central station can, in some way, balance or compensate for this leakage. We started in by adopting the method of demanding a guaranteed usage, and if the actual usage is under that guarantee, we charge it according to the guarantee, and if the usage is over that, we charge it in the same way. This seems to be rather an arbitrary plan, but so far it has worked satisfactorily, and has helped us out considerably.

Mr. T. Carpenter Smith: With regard to Mr. Baxter's experience as to leakage on the series of large installations eating up the income, I would suggest that the meter manufacturers should be encouraged to get up a meter which could be placed on the primary side of a converter, and let the customer pay for the leakage. He will then keep the number of lights that he is going to install down to those which he will actually use, and he will keep his converter capacity down as soon as he understands that he has to pay for whatever leakage there is. I know of one case where a house was wired for 127 lamps, but they actually used not more than 10 lamps, and these only for a few hours in the evening. When the installation was first put in the customer was very anxious to have the lights arranged so that he could turn them all on if he wanted to, and three 40 light converters were installed for him. At the opening the whole house was lit up, and his meter for the first month was a sight to bring joy to the heart of the company. But in about two months his bill got off so much that one day when a lineman wanted a 40 light converter for another customer, he thought it would be safe to take out one of those converters, and he did so. A few weeks after that a second converter and then a third was taken out, and he put in in their place a 20 light converter, and I do not think that the fuse in that converter has ever been blown since. He changed the meter from an 80 light meter to a 20 light meter, and the customer's bills are just about the same right straight along. Some time I suppose that he will give a party and may then be left in darkness, but that is his fault.

Mr. Leonard: Was it in multiple arc?

Mr. Smith: It was not in multiple arc. The owner of the house was willing to pay a very good price for his wiring, and he had his house wired in three circuits; that is, all the side lights in a room were on one circuit, all the chandelier lights were on another circuit, and all his hall lights and the lights that were used at odd times were on the third circuit, and these were coupled up to the three separate converters. Of course, when the lineman commenced to rob him of the converters, he put a couple of circuits together, and the three circuits are now run on the one converter.

The President: Will Mr. H. Ward Leonard give us his experience with converters?

Mr. Leonard: My experience in converter practice is largely in the future. I hope that I shall have a good deal of it, but my experience in the past and my knowledge of it is largely derived from the remarks I have heard from members of the Association, and from such things as I have read on the subject. Therefore, I do not feel prepared to say anything on the subject at present.

The President: If there be no further discussion on that subject, we will take up the paper of Mr. George A. Redman, of Rochester, N. Y., entitled "Central Stations Operated by Water Power."

(Printed copies of the paper having been distributed, its reading was dispensed with.—See Supplement.)

Mr. Redman: My paper is on central stations operated by water power, and in it I have given a description of what is being done in Rochester, and I would like to call the attention of members to the prices as given on page 5. They vary undoubtedly with the prices of some other cities, but you want to bear in mind that we use water power entirely. It has only been necessary during the past year to shovel coal for half a day, and that necessity was occasioned by the cleaning out of the raceway. Another thing that I would call particular attention to is the development of the motor service. We have two motor services—one running in the northern portion of the city, and the other in the northwestern—where, with very few exceptions, the motors are placed in dwellings or in small shops built in the rear of dwellings. Heretofore the small manufacturers resident there have done business in the center of the city, and on the fifth or sixth floors of buildings, but now they do their manufacturing at home, either in their dwellings or in small shops. As a boss tailor remarked to me the other day, when he did his work down in the city he only worked himself, but now, said he, "Mine frau and all the children work." I shall be glad to answer any questions you may ask with regard to the subject.

Mr. Armstrong: How much money do you make?

Mr. Redman: That is rather a leading question. We pay a dividend.

Mr. Armstrong: What I mean by that, of course, is, do you make unusual dividends from these rates or can you carry a large sum as surplus, or are you making only fair dividends?

Mr. Redman: We are making some money. Of course, in addition to our electric light business, we are renting water power for other purposes. We are renting 2,500 horse-power of water power.

Mr. Foote: Which branch of your business do you consider the most prosperous, the power or the light?

Mr. Redman: We are now developing the power and making special efforts with it. The incandescent light we hardly bother with.

Mr. Armstrong: I presume there is no company here but has had Rochester and other

cities (I will not name them, for you know the whole list) thrown at them by members of city governments and boards, whenever propositions have been made by electric light companies for municipal lighting. Now, we get 39 cents for 2,000 candle-power lights every night, and all night, while here the price is stated by Mr. Redman, on page 5, as 27 cents for city arc lights. I see that for commercial lighting, all night and every night, 40 cents per night is obtained by this company which only has to use coal for half a day during the whole year. The facts shown by these figures, as they go out, ought to be strongly emphasized, and the fact ought to be just as strongly emphasized that nothing but water power is used by this company. And the further fact ought to be emphasized that in addition to the fact that the water power cost nothing, so far as the electric light is concerned, 2,500 horse-power is sold. So that the incidental expenses, as I apprehend, and possibly the investment itself, is paid for by the sale of water power in addition to the sale of electric lights. Rochester, therefore, is doing a great thing when it is so far underselling us who have to pay high prices for coal, and who have to watch our boilers and our coal fires very carefully. Our general manager, as he has met the lighting committee of the city council, has had the figures of this city, and the figures of other cities using water power, as well as the figures of cities that burn coal—getting it for nothing and objecting to pay for the carting—has had all these things urged upon him.

Mr. Redman: You will notice that two other companies charge the same price. There are three companies doing business there.

Mr. Armstrong: And practically you get the same price. Are they also using water power?

Mr. Redman: Both water and steam.

Mr. Armstrong: My purpose in rising was simply to call attention to the fact and to impress it upon our minds, that these differences in figures is owing to the fact that the water power in Rochester furnishes the original power at almost, if not nominal cost.

Mr. Francisco: We charge the same rate for light and power—25 cents per thousand watts. But we have found, in respect to its use for power, that there is a vast difference in the kind of business in which the power is used. We are running a motor for a daily paper. They used to run that paper with water power and a steam engine, and it took them four or five hours to run off an edition of the paper. We started in, and they supposed that it would take the same length of time to run off the edition with our motor as it did with the water motor and the engine, and we based our contract upon that supposition. They have found since they put our motor in that it requires just one hour and ten minutes to run that edition through, instead of four or five hours. Our contract, however, was based on the experience which they have had with the water motor. They only use the motor while that edition is being run off—for the one hour and ten minutes—whereas, in another class of business, as in running an elevator, they will run the motor through ten hours of service. We are also running a freight elevator in a store, which is run on a meter. In the first place the man was afraid of the meter, and said that he would prefer to make a contract for a specified sum. He said that he had had some experience with meters—and, by the way, he is a director in a gas company. (Laughter.) He said: "I have had an experience with meters, and I will not take a meter." Said I: "Very well, we will give you a motor on contract." He said that that was all right. So we made a contract with him for the motor, but for my own information I put a meter in. At the end of the first month he paid his bill according to the contract. When I went there to look at the meter at the end of the second month he said: "Of course, it is nothing to me, but how much does that meter indicate? How much would it have cost me, supposing that I had been running according to that meter?" Said I: "Do you really want to know for your own information, or do you want to know for the purpose of applying it on the contract?" He said: "Of course, I cannot apply it on the contract until the end of the year, but I would like to know for my own information?" Said I: "It would cost you just one-third of what you are paying. If you had paid by the meter your bill would have been just one-third of what it is now."

Mr. Redman: What did you charge him?

Mr. Francisco: I charged him $60 per year for a five horse-power motor.

Mr. Leonard: Mr. Francisco states that he charges 25 cents per thousand watts. I want to ask him what he means by that? He does not give the element of time. Does he mean 25 cents per thousand watts per hour, per day, or per week?

Mr. Francisco: A thousand watts is 746 watts in horse-power. When a man uses 1,000 watts he has used a horse-power, and a fraction beyond that. When he has used 1,000 watts he pays 25 cents. That is our rule.

Mr. Leonard: That is a pretty heavy charge, I think, for power—it is 1¼ cents per hour.

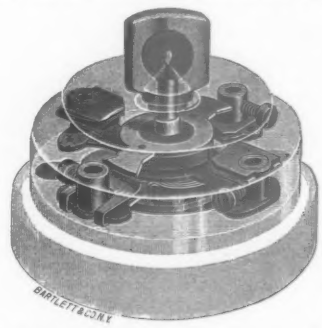
Mr. Francisco: But remember that we are running on steam power where coal costs us $4.50 per ton. And here is another picture: The entire installation is under our care. Everything that is required we have to do. Of course, if a man pays for the installation he should naturally get the current at a different rate. Where we supply everything, but he buys the motor, then we keep it in repairs.

Mr. Wilmerding: If we could get at the rate of 25 cents per 1,000 watts, we should prefer the meter, but I have found the meter system unsatisfactory, because the character of the service varies so much. Our charge for elevator service is from $5 per month to $15. That is on the basis of 10 cents per thousand watt hours. On our contract prices we make three rates. We have a rate for continuous power, a rate for intermittent power, and a rate for elevator service. For the elevator service we charge $5 per month per horse-power, or $60 per year. That is for any kind of elevator service. But I have never found that any of those elevators, when run on the meter, shows more than one-third of what our contract price would give us. I have also found that our customers are more surprised than we are at the small price that they have to pay for the service. For that reason I have concluded recently that we will not furnish any elevator service on the meter. (Laughter.) We do not want to surprise them in that way. That comes to the neighborhood of six cents per horse-power.

Mr. Francisco: What is the cost of coal?

Mr. Wilmerding: Our coal cost $2.65 per ton, but we are using compound condensing engines, and our indicated coal consumption is not more than two pounds per horse-power hour.

Mr. Ayer: There has been nothing said here with reference to constant current rates, and it may, perhaps, be of some value to some of us to know what the charges are in that way. We are running in excess of 200 constant current motors on arc lights, and we make a charge of $10.50 for a single horse-power for 10 hours' service, regardless of the character of the service. Wherever we happen to have a variable load, we indicate the load on those motors as the maximum load, and we insist on their making a contract based on that maximum load. If we find them bringing in additional machines later, our motor inspector is very apt to get track of the fact, and we soon know just what they are doing. We find no difficulty in making satisfactory arrangements on that basis. We find that on constant current motors the price has been satisfactory, and we have had no difficulty in making our contracts on motors at $10.50 per month per horse-power. For three horse-power and upwards we make the rate at $8.50.



NEW HART DOUBLE POLE SWITCH.—(See page 63.)

Mr. Wilmerding: I do not want to be understood as saying that we do not make a $5 per month rate straight through, but that is on elevator service. Our lowest contract price for the intermittent service is $6.25, and our lowest price on constant power is $9 per month.

Mr. T. Carpenter Smith: I would say that there is one advantage that a constant current motor has over a constant potential motor, and that is that a constant potential current will slow down if it is overloaded.

Mr. Dunham: What Mr. Smith says with regard to the motor is correct, as I have found in my experience that if a constant current motor is overloaded it will slow down. We run on an average of from 40 to 50 candle horse-power 2½ miles from the station. The maximum is 56 horse-power, and it runs down to 38.

The President: There is probably no one here, with the exception of Mr. Redman, who has had the means of obtaining accurate information concerning the production of power by water, but I believe that Mr. Leonard had quite an experience in that direction, and if he is in a position to offer us any facts concerning the cost of water power we shall be glad to hear from him.

Mr. Leonard: I have had some experience in connection with the running of stations by water power, and I think that the remarks of our speaker are very pertinent and correct, and that the cost of water power, although it is apparently cheaper than steam, is frequently higher than it would have been for a first-class steam plant. I think, further, that water power is really not sufficiently constant to entirely eliminate the steam plant. With the exception of a few plants, where the water power is peculiarly favorable, the water power has to be assisted by a steam plant, and the ultimate expense is frequently higher than it would have been if they had entirely disregarded the water power and built the steam plant at the best possible location. In my own experience I find that the best use to make of water power is not that of operating a full load, but of taking care of that portion of the load which is quite light, and which operates between, I will say, 11 o'clock at night and dawn of the next day, for the load is fairly constant during those hours, and the economy of the water power is then more marked, because it enables the services of an engineer to be dispensed with. The use of the water power has proved to be very economical in certain places where a not very reliable water power existed, but where, perhaps, 50 or 100 horse-power could be obtained at almost any period of the year, and which would answer to carry a light load during certain hours of the day and late at night.

Mr. T. Carpenter Smith: I would say that this question of the relative cost of steam power and water power, has been very fully considered in some papers which were read before the American Society of Mechanical Engineers, and notably in a paper read last year by Mr. Manning, of the Amoskeag Mills, at Manchester. He states that his experience has led him to the conclusion that, all things considered, steam will, under almost any conditions, if properly handled, be produced as cheaply as water power. I think that at most central light stations the best use to make of water power is to use it in condensing. Steam has an enormous advantage over water power in that with steam you can state almost to a certainty just what your power will cost you. A paper which was read some years ago by Mr. Louis F. Lyne, on the use of headlight oil for keeping boilers clean, is also worthy your attention. I read that paper and tried that oil, and had such success that we have used it ever since. But, of course, the oil must be used intelligently, and I have found the method given by Mr. Lyne to be the best. We have tried it several different ways, but find that his method is practically the best. Those two papers I think are well worthy the attention of the members of this Association.

The President: The next paper is that of Mr. H. Ward Leonard, of New York, entitled "A Central Station Combining the Advantages of Both the Continuous and Alternating Current System."

(Mr. Leonard's paper will be found in our Supplement.)

Mr. T. Carpenter Smith: We have been accustomed to speak of the efficiency, the reliability, the safety, the easy adaptability of any of the various systems in use, only with reference to the relation that those features bear to the central station itself. The consequence has been that all currents using high tension have almost, without exception, in the first years of the business, been installed in such a manner as to be a serious menace to life and property, and, therefore, have been universally condemned by the unitiated public. I wish, therefore, to say, that whatever remarks I may make are based upon the relation of electric lighting to the public, and not its relation to the central station. With that statement as a starting point, I wish to join issue at once with Mr. Leonard in his statement that the alternating system suffers by comparison with the three-wire system, for its efficiency is much lower, its reliability is less due to the fact that its machines are not practically operated in multiple arc, its safety is necessarily less due to the existence of the high primary pressure, and its current is not adaptable to commercial use for motors, charging storage batteries, electro-deposition, etc. I will start out at once with the first of these, as to its efficiency being much lower, and will say that the efficiency from the standpoint of electrical engineering, the average efficiency during the 24 hours' load, the converter system as at present installed may be lower than that of the three-wire system. But with regard to the satisfaction of the public, I think that the efficiency of the alternating system is considerably higher. I have been operating for nearly four years the alternating system and we supply 3,000 lights in a district of the area of six city squares. We cannot go any further because we cannot get a franchise. Our district is honeycombed by the three-wire system. Their central station is within a block of us. Their wires run down every block on which ours are found, and on some blocks where ours are not. They have connection in nearly every building in that district, and yet they have never succeeded in taking a single light from us. On the contrary, we have taken several customers from them, simply on the ground that their customers could not stand the poor regulations. The sudden changes in the light annoyed customers so much that they preferred to come to us. We have never lost a customer from bad service. We have thrown several off, but we have never lost one. Mr. Leonard says that "its reliability is less due to the fact that its machines are not practically operated in multiple arc." I do not think that that amounts to anything, and for this reason, that while the machines are not generally operated in multiple arc, still they can be, and if there were any necessity for it they would be, so operated. I do not think there is any necessity for it, and I prefer not to do it, because I think that in case of accident to any one machine there is far less danger of accident to others. Any one machine being broken down does not give you the risk of breaking down other machines running on the same circuit. The time required to throw in the switch of a relay machine is not more than the time which is required to throw in the switches which Mr. Leonard uses for transferring from one system to the other. In actual practice, that simply amounts to the winking of the lights for an instant. Another advantage, and one in which safety is also concerned, lies in the fact that the alternating system has its road divided up into small units. That is to say, no matter how badly the wiring may have been done in any one building it does not affect any other building, and one customer cannot threaten the safety of every other customer of that station by having his apparatus or the wiring in bad condition. The failure of one group does not affect any of the others. The alternating current in itself, from the mere fact of its being an alternating current, has an immense added safety in the fact that it will not strike an arc. A very serious question which was brought before the Committee on Safe Wiring is one that we have got to face before very long and to consider seriously, and that is the grounding of the neutral wire. There have been several arguments brought forward why this should be allowed. It practically came down to this, that the insurance agents and inspectors have preferred to ground the neutral wire, and practically make a return to the one-wire system of installing electric lights, to avoid the much greater danger of the 220 volt arc between outside wires, and the consequent damage in buildings where combination fixtures are used. Now, I do not know whether it is not a good thing to go back to the one wire system of wiring. That is an engineering question that we shall have to determine by years of experience. But I do know that if the grounding of the neutral wire is permitted you must also permit the grounding of the transformer. You cannot make fish of one and flesh of another. And, more than that, I do not believe that is the real reason of the desire for the grounding of the neutral wire, but that it is rather due to the fact that any failure of the third wire would cause the blowing out of the lamps one side or the other, according as the load may be placed. That objection would equally apply to Mr. Leonard's plan of wiring up all lights on the three-wire system. I think that the inherent defects of the three-wire system are enough to forbid its use. The two-wire system will meet those conditions. You can do your wiring on that system, if you please, on 100 volts—although I think myself that the lower voltage we get and the larger the conductors we get, the better safety we get—and the slightly additional cost in installation is generally borne by the consumer. The statement that with large converters we get cheaper first cost, higher efficiency and better regulation of pressure, I fully agree with. The statement that the safety of the alternating current is necessarily less due to the existence of the high primary pressure, I beg to deny. The three-wire system in use gives an absolutely continuous metallic contact from dynamo to lamp, from street main to lamp, and from every lamp on a circuit to every other lamp on that circuit. These three-wire systems, finding that they could not operate their street circuits with any economy, have installed high tension machines, carrying considerably higher voltage in many cases than the ordinary alternating system. It is very evident that the first contact between that high pressure wire and the street main at any point, however light it may be, puts that high tension on every lamp on that circuit. To do that with the alternating system you have to break down the insulation of every converter. Personally, I have never known of a case of contact between the primary and secondary coils of a converter. I know that such have occurred, but I do not think that there has ever been one worth considering, when we think of the enormous number of converters that have

been put into service, the immense strides that have been made by the alternating system, and the small knowledge we had of it when we first started to install it. Those are accidents which will teach us lessons, but which should not lead to a condemnation of the new system. The high primary pressure we must have, no matter whether we use the continuous or alternating current. We cannot carry the current without it. It is exactly the same as with water pressure or with steam pressure. Twenty years ago 50 pounds was considered high steam pressure. To-day 80 pounds is the average. I do not think that of the new boilers that are being installed less than 25 per cent. are being put in for a pressure of less than 150 pounds, and in ten years 150 pounds of steam pressure will be used where 80 is now used, and 200 pounds where 150 is now used. We know that in all new stations that are being installed, in all new plants where steam is being used for power, the constant tendency is to raise the pressure. It is kept safe simply by the addition of proper precautions, due to the increased pressure. The statement as to its current not being adaptable to commercial use for motors so far would seem to be proved, but four years ago that same argument was brought forward—that the current could never be used for meters. I think that the alternating current meter has pretty well fought out its own case and worked out its own salvation. I do do not think that to-day there is any direct current meter on lines in which they are in use which can compare with the meters which have been brought forward as the direct result of the introduction of the alternating system. I, therefore, think that in a few years we shall see the motor in the same way. We do have a demand, however, for power, and so far we must admit that the alternating motor, except in small sizes, is not well adapted for use for certain central stations, although it is of great use in isolated installation. I think, however, the experience of every central station is that it is better to have separate circuits for power and for light. And I think that this plan will meet fully all the requirements of the central station, and that you can use the alternating current for your lighting and the continuous high tension constant potential circuits for your motors. That constant potential circuit can be used for charging storage batteries and for any of the other purposes for which the direct current is used. The safety to the consumer by the use of converters is not only limited to the accidents from the system itself, but it also has its value in the case of light installments. I do not believe in the use of small converters. I think the larger you can keep your converters the better, but yet we have to weigh very carefully the disadvantage of having too few lights on one converter and too many lights in one group, where, by grounding one part of the group, you may affect the safety of another part. It is between those two limits that we must fix upon our most efficient size of converters. The same rule holds in figuring up the sizes of conductors. In figuring up the size of blast pipes used in our large rolling mills, and in the size of water mains, that question is continually coming up, and the limits on one side are the interest on the extra money extended in the first place, and the loss by friction, or by resistance, or by pressure, or whatever it may be. The use of the two systems in this way by keeping all the customers continually wired up upon an alternating system avoids great danger of connection between your high tension wires and your low tension main. If your high tension wires get crossed with your high tension direct wires for the supply of power the station may be hurt, but the consumer is not likely to be. Say what you will, it comes down to this, that it is the consumer who will regulate the running of your station. If he does not regulate it by legislation he will do it by hurting your business, by refusing to take what you supply, under arbitrary conditions. And so we come back to the proposition with which we started, that no corporation, individual or government can say, "The public be damned" and not suffer for it. (Applause.)

Mr. Leonard: Mr. Smith seems to have made the error of assuming that I am appearing in the role of an advocate of the three-wire system. If such an impression exists I wish to correct it as promptly as possible. My remarks with reference to the three-wire system and the alternating were such that they would be admitted by almost every one to-day. I presume that any one familiar with the facts would admit that the average efficiency of the three-wire system was higher, that it was conspicuously higher at loads, and in speaking of the possibilities and advantages of the system which I have proposed, I was only giving consideration to the existing conditions of to-day. Mr. Smith spoke of the disadvantages of operating the multiple arc. And yet it seemed as though the universal opinion must be that a multiple arc arrangement of dynamos is preferable to a separate one, when we remember that in the first part of the business of electric lighting machines of constant potential were operated on separate circuits, and that they have been gradually placed in multiple arc is due to the advantages gained thereby. I think you will almost never find to-day an isolated plant, where we have a large number of machines supplying a constant potential distribution, in which each machine is supplying a separate circuit. The possibilities of regulating and the economies are so much higher when machines are in multiple arc that, entirely outside of any consideration of central station supply, or of three-wire system, it seems as though the result of experience has been that where machines can be operated perfectly, simply and reliably, with multiple arc it is better to do so. With reference to the question of grounding the neutral wire, I can dismiss that by stating that I agree thoroughly with Mr. Smith, that the grounding of the neutral wire is extremely bad practice, and that there is no argument for grounding the neutral except, perhaps, that of laziness. As to high pressure primary, the paper which I have read, of course, bears evidence in itself that I am a thorough believer in the necessity of high pressure primaries for reaching any great distance, and there certainly appears to be an advantage in having those high pressure wires as few in number as possible. And, instead of having a complete network through the city of high pressure wires, if we can, by any means, obtain a few of the high pressure wires to centers, there would be less liability to any trouble due to the existence of high pressures. Mr. Smith has mentioned that in his belief an alternating current motor will soon be attained in practice and ready for service. I thoroughly agree with Mr. Smith on this point, and have no doubt that an alternating current motor will soon be ready for commercial service—but how soon is a question. In the meantime, the existing condition to-day is that the central station manager cannot secure an alternating current motor to put upon existing circuits, and in fact the work which is being done on an alternating current motor thus far is not of a kind to indicate that an alternating motor which can be placed upon the same circuit as an incandescent lamp will result. One point I will state before going further: All of my remarks have been on the basis of the three-wire system merely because of the saving in the cost of conductors which is attained thereby. Were we able to have a 200 volt lamp instead of 110 volts it would be, of course, infinitely preferable to have the two-wire system and use a 200 volt lamp than to have three wires for a lamp of 110 volts on each side, and, furthermore, the cost would be reduced even beyond that of the three-wire system. As to the sub-station method of operating on the outskirts of the town, that is, unquestionably, when the alternating current motor is at hand, a very desirable way of operating. And yet it seems to me that even there, until we have our 200 volt lamp, it will be extremely advantageous to use for distribution something which will enable us to reduce the cost of our conductors on the consumer's premises to a point far below that of 50 volt lamps. As I have pointed out in the paper, the cost at the same distance, and at the same percentage of loss in conductors, the cost of a three-wire system will be but one-twelfth of that of a two-wire system with 50 volt lamps, and if we had 200 volt lamps with the two-wire system and our secondary distribution, it would be but one-sixteenth. Consequently, when we have delivered our high pressure to the sub-stations, and are ready to distribute to our consumers, we would have to have a very large number of sub-stations in order to operate 50 volt lamps, or else we must have an enormous expenditure in conductors. It seems to me that under the existing conditions it will be well, and indeed, the best way we have at present at command, to use the three-wire system, as it does enable us to distribute from that center at low pressure and at the least cost. When the time comes that the 220 volt lamp is commercial, the three-wire system will, of course, still present the advantage of being able still to reduce the cost, but the high pressure which will be realized then may be a sufficient argument against the use of 500 volts in the premises of the consumer and may make the 200 volts satisfactory.

Mr. Smith: My remarks about the three-wire system were not made with any idea that Mr. Leonard is upholding it as against the alternating, but because he in his new plan calls for all inside wiring to be done on the three-wire system for lamps of 110 volts. I apparently did not make it clear that the 200 volt direct current in the building is what the insurance people are afraid of now, and that, consequently, we must abandon that in any new system which is to be an improvement on that. The use of an alternating current of 220 volts I do not believe would have that disadvantage, and in that case Mr. Leonard's plan would be all right. But as his plan contemplates using during a part of the time a continuous current of 220 volts, I feel that the 220 volts should be barred altogether. Of course, on a 55 volt lamp we can use the three-wire systems, and in many cases where buildings have been already wired we may get a proportion of reduction of copper in that way. With regard to the multiple arc, I would say that, in my experience, the multiple arc, in isolated work, has been used to save the running of new feeders.

Mr. Leonard: I think that Mr. Smith has made a very ingenious argument upon the multiple arc question, but I hardly feel that his position is sustained by the facts or by practice. Of course, as he has pointed out, where conductors are placed on one dynamo and the load gradually increased, they are driven to the multiple arc arrangement, unless they are going to put in new conductors. The fact is, that every large isolated plant that I have ever had occasion to bid on has been so specified and rated by the common consent of all companies that have entered bids, that the dynamo shall be multiple arc when there were eight or ten at the beginning, and it is the universal practice in all companies to so design their plants, and, hence, the multiple arc arrangement is one that has been forced by the unexpected enlargement of the plant, rather than by a deliberate design to obtain the best results in the beginning. Mr. Smith has spoken of an arrangement of sub-stations, but he has not yet pointed out how he gets rid of the losses that will occur upon the final converters. He has put an intermediate set of converters in, and has taken means to take out converters as the load diminishes, but his final converters in his distribution throughout the city are still connected, and are the same as we have had before.

Mr. T. Carpenter Smith: I would use the same plan as Mr. Leonard proposes in his system. I would have them grouped and switched in and out by the operator, just as I do in the sub-stations. I am only comparing one system as against the other. With regard to the multiple arc, I will say that I still hold to my proposition that multiple arcing is not put in because it is a great advantage, but it is put in to allow of two machines being connected together. It is a good thing, simply because in an isolated plant the conditions are different from what they are in a central station.

Mr. Leonard: Mr. Smith explained how he was going to reduce the loss of the final converters of the circuit by throwing off a part of the load when the load became too heavy. This necessarily assumes an arrangement of converters in multiple arc on the secondary, which is not contemplated in my scheme and is not in practice to-day.

Mr. Bell: At the risk of stirring up all parties in this discussion, I want to make one or two suggestions with regard to this scheme, and the first of them is to suggest the question as to whether or not a 220 volt alternating circuit is a pleasant thing to have around the house. I have very grave doubts about that. I am not afraid of the direct circuit or of 220 volts straight circuit, but when it comes to turning loose 220 volts on a three-wire system, alternating around and about the house, it seems to me that it is a good thing to avoid. I know that there are plenty of alternating current men who say that they have no fear of a current of 1,000 volts.

Mr. Orford: In Bridgeport we have been running the three-wire system, and we have had 3,000 lights in operation. The question of danger that Mr. Smith spoke about we know nothing of. We have never had any trouble whatever in that way. We have had a few fuses blown, as every person has had, but as for fires, we have never had any. We are able to distribute the current from the dynamos to a distance of three-quarters of a mile, giving us a pretty large district in which to distribute the current. But we found that we had some outlying districts that we were not able to reach, and then we began to inquire into the question of putting in an alternating plant. The only way I could make inquiries was to go around to central stations and try to find out what they were doing. I would go to the manager of the central stations in the several towns, and when I talked with him, so long as he thought that I was a stranger to the business, he would represent the matter as being eminently successful in every respect, but when I came to asking him a few leading questions he would sometimes turn and ask me why I asked the questions and who I was. One question I put to him was this: "Have you been able to displace gas altogether?" He said, "No; certainly not." "Do you advise your customers to take their gas fixtures out?" "No; what would we do that for? What would we do if anything happened our lights?" I found that that information was sufficient for me. I found that the alternating system with him was not even an alternating one, but that you had to alternate it with gas. There was one gentleman that I asked the question of who had had experience with both the direct and alternating systems. He said that the only thing he could say for the alternating system was that it was very destructive. It certainly had no advantage that he could state over the direct system, except that you could go further with it, but when you attempt to go further with it you have to put in just about as much wire as you would under the other system. Then you have, on the other hand, the continuous watch to keep upon your customers. With our 650 light machine that was the point that I carefully watched, but as our maximum increased—say, up to 12 o'clock—we would have a ratio of one-third increase right straight along. Even if those converters had no lights on them they would still run one-third at a loss. Of course, we inquired into the cause of this from the parties who had sold us the apparatus, and, incidentally, one of them admitted that it was due to the converter. But he thought better of that afterwards, and he had some one seat down to explain that this slowing up, after 12 o'clock, although it indicated amperes, yet it took no power. I rather doubted the assertion, and so I made the test, and found out that it did take power. We are so satisfied with the continuous current in Bridgeport that it has been adopted in New Haven and some other places. They have an alternating system in New Haven also, but it is the occasion for many complaints. It may be that the complaints are due to the fact that they are not able to operate it. I think that in Philadelphia, where Mr. Smith is able to give better service than the man with the continuous current machine, he must have a very poor manager for the competitors. I think that I could wake them up a little bit. I do not think that you would see any variation in our light at 8 o'clock in the morning. We put our machines in, and they go from 100 amperes on each side up to 1,000, and I defy any one to tell when we put a machine in or when we take it out. We are running what may be called a bastard machine.

Mr. T. Carpenter Smith: Replying to the last speaker, I would say that this is simply an individual case where, by first-class management, he has got a first-class station, and I would say in this case, as I said in the case where I was asked to select the manager for an alternating station, that I would not ask for any better man to run an alternating station, because he has shown that he can handle a central station, no matter what it is, whether direct or alternating.

Captain Brophy: Mr. Chairman, I think

QUEEN & COMPANY'S IMPROVED PORTABLE TESTING SET.—(See page 64.)

all of you will understand the delicacy of my position. I am dealing with people who use both systems. I do not wish, under any circumstances, to take sides in that discussion. I do not think it would be proper for me to do so. Perhaps I have had as much experience in watching the good and bad points, or seeing the good and bad points, of both systems as any one, owing to the position I have held. It would be very unfair for me to give to the public the weak spots in any one system, if I knew them. They both have their good qualities. I only wish to say one thing in regard to the matter of fuses. I have studiously insisted on increasing the size of fuse. The system of using a certain sized fuse for a given number of lamps has caused a great deal of trouble and annoyance. As a rule, in the central stations the fuses are altogether too small. They should never be below the safe carrying capacity of the wire, and in 95 cases out of 100 they are, except perhaps in our own territory, where I have insisted on their being increased. Now, I am very glad to have listened to the discussion between the two gentlemen. I believe you are all intelligent enough to draw your own conclusions, and that you will shape your action according to circumstances. I am one who does not wish to alarm the public. I am one who has met on every occasion when it was possible the alarmists and combating them. I believe that if we use high potential or dangerous currents we should let the people know that they are so. We should not introduce into their houses, for their families to use and handle, anything that we consider dangerous and not let them know.

As to the matter of fire, I wish to say here that the losses from fire by the introduction of the electric light system has been too insignificant to take notice of. It is true that it is said that one of the largest fires in Boston for years was caused by the electric light. There are certain officials all through the country to-day—some of whom are more ornamental than useful—whose duty it sometimes is to determine the cause of a fire, and they very often know very little about it. In years gone by the standard cause of a fire, when no other cause could be assigned, was spontaneous combustion or matches. Now, it is electric light wires. I trust that all you gentlemen will see that you install your wires as carefully in the future as you have in the past and improve on them. (Applause.)

The President: Is there any more discussion on this paper? If not, we will proceed to the next paper on the programme, by Mr. Burleigh, on "Uniformity in Method of Keeping Central Station Accounts."

(Mr. Burleigh read the above-titled paper. See Supplement.)

Mr. Burleigh: I know of the many difficulties in bringing this matter before the attention of the convention. I know of the many difficulties that beset the way of a uniform classification of accounts. We have all fairly started on our way with our own particular plans. To change them would be embarrassing in many, perhaps in all cases, but great good would follow a uniform classification. I do not mean that we should all keep our accounts alike, but that we should agree on certain headings for our expense charges, and what items are to go to those expense headings. So that when I hear my neighbor say that his arc light cost him so many cents per arc light hour I know what makes up that. I know whether he includes interest or not. Some keep a depreciation account, others do not, and so on. The forms that are appended have no particular merit over other forms. My whole thought is to get a uniform classification of expenses.

Mr. Nicholls: I have listened with a great deal of interest to this paper and I shall consider it of more interest still when I have an opportunity of carefully, and at my leisure, going into the varied detail schedules that Mr. Burleigh has prepared. But as it may be of interest to the Association, I will draw attention to two points which I have adopted in my practice which I find of incalculable value. To begin with, I have two private abstract books bound, with a lock and key on them, so that while they are kept in the regular vault they are not accessible. In the first book I have our charter under which we operate. I have our agreement copied in, our agreement with the city, our franchise. I have our different agreements with the different companies with which we do business. In addition to having all those put down in this book, I have them indexed and cross indexed. If I have to refer to any particular clause or agreement as to powers of any kind, I can, by looking at this index, find it at very short notice. I periodically read over these agreements, because there may be a clause in an agreement that you have pigeon-holed which appears of no earthly use to you to-day, but a year from now you may find it gives you certain advantages, or that under that agreement certain rights accrue to you which you have forgotten and which you wish immediately to take advantage of, and I think any central station manager will find a system of that kind of great advantage.

Then we have a monthly abstract of earnings and expenses. We bring everything right up to the end of the month, and I insist on having it before me not later than the 12th or 15th of the month following. In addition to having that copied out into my private abstract book, I have the cost of our power, as compared with the variable expense of the station, made up to what I estimate at the engine, the bussbar and at the service, allowing for the average drop. I also have the cost of our total power turned out compared with our total earnings. Then I take our light. I know whether we do our business by the meter basis, and then I figure actually what we get per horse-power per hour for our earnings from incandescent lamps and from our meters, and if I am called upon to make a contract at any time I can tell for every preceding month the average. I can tell what it has cost to produce our power at the engine, at the bussbar and at the service, for every month since we have been in operation, and, consequently, I am in a position to know exactly what we are doing. I do not know whether that is the general practice, but I find in my experience that it is of very great interest.

(General discussion followed from Messrs. Francisco, Nicholls, Burleigh, Scott and Judge Armstrong.)

Mr. Peck: I would suggest that this is a very important matter, and as we have a committee on data, that that committee be instructed to appoint a sub-committee on station accounts, and that they gather all the statistics that they can before the next meeting and report as to some general system of station accounts at our next meeting.

Mr. Burleigh: Speaking to Mr. Peck's suggestion, I doubt if we could ever agree on a uniform keeping of accounts. But we might arrive at a uniform classification of expenses—we might limit it to that.

The President: I assume that almost every man who has formulated a lot of accounts to carry on his business thinks that his accounts are, as a rule, kept about right. Fortunately, or unfortunately, personally, we in Buffalo have had access to as good an accounting system as exists in the country. Members of our company are closely allied to a corporation about which some of you know, and it is called the Standard Oil Company. They have a gas interest which is rather far-reaching. What is applicable in the main to the gas interests is applicable to the electric light interests. We have taken many of the methods that they employ in accounting and, in fact, our books are practically what they have. From time to time it has seemed wise to make changes, and invariably when those changes are suggested to the accountants of the office they look very tired and say, "I have got all the work I can do, this is more than I can take care of," and where one has a large station to care for he must necessarily entrust that to his chief engineer or his chief dynamo man, or those in charge of the station, and the repairs and material there have to be accounted for by him. They have, as a rule, no ability as clerks. They are handy with a lead pencil and they can memorize things fairly well. We have got a lot of blanks out which seem to cover the ground fairly. All our material is charged into the station, and as each dynamo has its work to perform we have whatever that dynamo costs. All the parts of that dynamo are printed up, and as we are operators of a system that sometimes burns out an armature, we have a diagram on the back of that showing the bobbin of each armature and we indicate when that armature burns out and the causes of it. At the end of a month those are sent into the office and the items are extended out into dollars and cents and those are carried out into expense and maintenance of the dynamo. That is true of the boilers and engines and our line repairs and general construction work. We have what is called a voucher ledger and at the end of the month the bookkeeper has only one entry to make in his ledger. There is nothing done in the ledger, other than August, September—whatever date it may be—so much. But that voucher is carried out into about 20 different columns. At the end of the month you can see exactly what those items are, whom you paid this money for and refer then back to the voucher, which is, as a rule, audited before any account is taken of it, both where we are buying goods and where we make other entries, having two different colors of paper to designate our purchases and our disbursements. That simplifies bookkeeping and with the very many accounts which we have, we find in a business of our size that we handle them very easily, and at the end of the month we know exactly how much our expenses have been for that month, and if the board care to look into the details of it they can be readily obtained. But we have one column which shows what our expenses have been beginning with the first of January and the excess of expenditure or decrease, as the case may be, using red ink for increase and black ink for decrease, and that is carried on from month to month. That serves the purpose very well with us and it serves the purpose very well with the gas interests of the Standard Oil Company, as well as their other interests. When we make an installation with a plant or building we have a form and everything is put down on that. That is countersigned by the superintendent and foreman of the construction gang. The prices are carried out in each individual case and that is pinned to the contract. That disposes of that in a manner peculiar to ourselves and we charge off a certain amount to profit and loss. When that service is discontinued we have got an investment in this customer. We can go at once to the contract and find that his contract has cost us $25 to install that place. We have cut-out, switch, and all those appliances in the building, so much wear, and other things. When that comes back to the store room there is an accounting made to the office. Our store rooms and stations are supplied, then a comparison is made of what is left of that stuff. The original entry is there with the contract, and what comes back to the store room from that place is accounted for. In very great losses, we inquire where has this stuff gone to, and we find that since adopting that system it has resulted in more care on the part of the various men in bringing back the wire, converters and other appliances in the places.

In the matter of cash, we have a daily statement, which, I presume, almost everybody has. It is practically the same which Mr. Foster has in his. Many of the blanks which we use are very like Mr. Foster's, although I think he has gone into a more elaborate accounting than we employ. But I think that with us it is almost imperative that the thing should be as simple as possible, on account of the bookkeeping in the establishment. While it is very desirable to have a good accounting, if we should employ an elaborate set of blanks—and the results, of course, are desirable to a few—it costs $1,000 or $1,200 a year more to obtain. Perhaps the end would justify the means. I have no doubt that it would. I would say here that if any member of the Association would like a copy of what we have there, I should be very glad to forward blank sheets of our voucher records and other books and blanks to them. I have already sent quite a number of them out, and I think Mr. Ayer and a few others have those, but it is not anything that we can take any great credit for ourselves, for the reason that I stated.

On motion of Mr. Seely, the convention then adjourned until September 10, at 10 A. M.

Fourth Session—Thursday, Sept. 10.

The Association met at 10 A. M., and the President read an invitation from the Business Men's Association of Norfolk, Va., to hold the next meeting of the Association in that city. Also an invitation from Robert M. May, Mayor of Augusta, Ga., and from the Cotton Exchange of Augusta, Ga.; from the Exposition Company of Augusta, Ga., and from the Commercial Club of Augusta, Ga., to hold the next meeting of the Association in that city.

On motion of Mr. Armstrong the invitations were received and referred to the executive session.

The President: The first business in order this morning will be the reading of the paper by Capt. Eugene Griffin, entitled "Three Years' Development of Electric Railways." The copies of the paper have not yet come from the printer, but will be received in time for distribution this afternoon.

Mr. Griffin: I feel that a few words of apology are due with reference to the paper that I am about to present. I was asked some time since to write a paper for this convention, and was given ample time in which to do it, but, as you all doubtless know, the pressure of electrical business is something quite enormous at the present time, and I have found myself so occupied with business that I have had very little time to devote to this paper. The result is that the paper was not written until Saturday and Sunday last, and was not typed until day before yesterday. I, therefore, beg your indulgence in what I have to say, in view of the very short time I have had in which to collect these facts.

THREE YEARS' DEVELOPMENT OF ELECTRIC RAILWAYS—BY CAPT. EUGENE GRIFFIN.

The first recorded description of the electric car is found in the fourth verse of the second chapter of Nahum: "The chariots shall rage in the streets; they shall jostle one against another in the broad ways; they shall seem like torches, they shall run like the lightnings."

Notwithstanding this early mention, it was not until 1888 that the electric railway became a practical commercial success. I fix the date at 1888 as it was in that year that Bentley and Knight opened the Allegheny City road to regular traffic; that the Sprague Company equipped the Richmond road, and the Thomson-Houston Company installed the Eckington and Soldiers' Home road in Washington. It was in 1888 that railway officials began to realize the possibilities of this new tractive force; that the great West End system of Boston adopted electricity to the exclusion of cable, and that orders began to flow in upon the electric companies for street car motors to such an extent as to soon make the manufacture of such motors one of the leading branches of the electric industry.

Previous to 1888 electric motors had been used on several roads. Some of these roads were doing well and have been prosperous since; but to the public these were experiments on a comparatively small scale, and did little to inspire general confidence. The early inventors found it difficult to secure adequate financial backing; orders were few and business unprofitable. The stronger companies which took up the work in 1888 had the organizations and capital necessary to achieve success.

The pioneers who devoted their brains and frequently their purses to this work previous to 1888 are deserving of all credit. It was their misfortune, not their fault, that their ideas were not developed and worked commercially. It is difficult for one man to combine the qualities of inventor, manager, superintendent, seller, expert and financier, and yet this is what Van Depoele, Daft, Bentley and Knight and others had to attempt. The record of their efforts is an interesting one, but the chronological record of electric traction has been so frequently given that it would be a waste of your time to repeat it again.

There are, however, one or two of the early trials that are specially worthy of consideration, not only because of what was actually accomplished, but principally on account of their bearing on later developments. On July 27, 1884, an electric car was running scheduled trips over a mile of track of the East Cleveland Street Railway Company, in Cleveland, Ohio. This was the first electric car in regular operation on a street railway track in the United States. The motor was placed between the wheels and supported from the car body, and geared to the axles by belts of spring wire cables. The current was conveyed to the car by conductors supported on insulators in a small, wooden conduit, and connection made with the conductors by means of a plow extending through the slot to the conduit. This was the initial installation of the Bentley and Knight system. Mr. Bentley has a photograph of the car in his office in Boston.

The road was given up in 1885, and the Bentley-Knight works transferred to Providence, R. I. After various experiments the road in Allegheny City was begun in the summer of 1887. The cars were started during the winter of 1887-8, although the road was not formally opened to traffic until February, 1888. Four cars were furnished to this road which, I believe, are still running. On the lower end of the road was a mile of double track conduit which was continued by an overhead system of about five miles. The conduit was on a long grade of about 12 per cent. Over-running trolleys were used with the overhead system. The conduit was in operation for two years or more, but has now been taken up and replaced by the overhead system.

As early as 1874, while C. J. Van Depoele was engaged in Detroit, experimenting with electric motors, generators, etc., it occurred to him that trains of cars, and even ordinary street cars, could be run by electricity. This was demonstrated to the satisfaction of his associates in various ways, but no public exhibition was made until 1883. When the Chicago elevated railway was under consideration it was proposed to demonstrate the feasibility of utilizing electricity as a motive power. A track 400 feet in length was built, with a five per cent. grade in the center. One car was equipped with a three horse-power motor and ran for several weeks with considerable success, carrying crowds of people. This was in February, 1883. In the same year an elevated railway car was operated electrically at the Chicago Inter-State Fair. The car was suspended from the track, instead of being mounted on it, and was in operation during the entire exposition—some 50 days.

During the Toronto Annual Exhibition in 1884, an electric railway, some 3,000 feet long, was operated from the entrance to the grounds to the main building. This was a conduit road and the wires carried a potential of over 1,000 volts without accident. A 30 horse-power electric locomotive was used in hauling trains of cars.

The Van Depoele Company subsequently equipped roads at Minneapolis, Minn., Montgomery, Ala., Detroit, Mich., Windsor, Ont., Appleton, Wis., Port Huron, Mich., Scranton, Pa., Lima, Ohio, Binghamton, N. Y., Ansonia, Conn., Dayton, Ohio, Jamaica, N. Y., St. Catharines, Ont., and elsewhere, many of which are still in operation.

In the fall of 1887, Frank J. Sprague contracted for the electrical equipment of the Union Passenger Railway, at Richmond, Va. This was an important road in a large city and Mr. Sprague's undertaking was the most ambitious effort in this direction up to that date. It is worthy of note that Sprague's original intention was to use motors with but one reduction, but he was forced to abandon this idea, as none of the electrical companies at that date were able to produce single reduction motors. The motors used at first were too light for the work, the copper brushes scored the commutators badly and were rapidly consumed. Nevertheless, Mr. Sprague persevered, despite all obstacles, and in 1888 the road was running with so much success that it was one of the object lessons which induced Henry W. Whitney and his brother directors of the West End Street Railway of Boston to adopt electricity as a motive power, when they were already far advanced in the plans for cabling their system.

As nearly as can now be ascertained, the following electric roads were actually in operation on January 1, 1888:

ROADS.		LOCATION.	MILES.	MTR. CARS.
Union Pass Ry. Co.	Daft	Baltimore, Md	2.00	3
Windsor Elec. Ry.	Van Depoele opp.	Detroit, Mich.	1.25	2
Appleton "	"	Appleton, Wis.	5.50	5
Port Huron "	"	P. Huron Mich.	2.75	4
Highland Park	Fisher	Detroit, Mich.	3.25	4
Scranton Sub. Rd.	Van Depoele	Scranton, Pa.	5.00	12
Los Angeles Electric Ry. Co.	Daft	Los Angeles, Cal.	5.00	6
Lima St. Ry. and Motor Power Co.	Van Depoele	Lima, Ohio.	4.00	8
Columbus Consolidated St. Ry.	Short	Columbus, O.	1.00	2
St. Catherines St. Ry. Co.	Van Depoele	St. Cath's, Ont.	7.00	12
Seashore Electric Ry. Co.	Daft	Asb'y P'k, N. J.	4.00	18
San Diego St Ry Co	Henry	San Diego, Cal.	3.00	9
East Harrisburg Pass. Ry. Co.	Sprague	Harrisb'g, Pa.	4.50	10

A total of 13 roads, 48.25 miles of track and 95 cars.

On July 1, 1891, there were 354 roads in actual operation, with 2,898 miles of track equipped electrically, and 4,513 motor cars. Such has been the growth of three and a half years.

This development has been marvelous and unprecedented. Referring to it, General Francis A. Walker said to me, not long since, that it seemed as though at least 30 years normal development has been crowded into three years.

It has, indeed, been a fruitful period, and the progress has been so rapid that the public are just beginning to appreciate the benefits which science has conferred upon them by the adaptation of the electric motor to street car propulsion.

During the past Spring the legislature of the State of Massachusetts was considering a proposition

which practically amounted to the imposition of new taxes upon the West End Street Railway Company, and the abrogation or virtual annulment of certain vested rights which the company might claim. In his able and vigorous defense of his corporation, President Whitney was forced to investigate and determine the true relations which exist between his company and the public, and he was surprised himself to see how closely the welfare of the city of Boston and its surrounding suburbs was identified with the welfare of its street transportation system.

He at once entered upon a "campaign of education," and his speeches in Somerville, Roxbury, Dorchester and elsewhere (several of which have been published in pamplet form) are masterly, impressive, straightforward and convincing presentations of the close relations which exist between the rapid transit systems and the health, wealth, morality and prosperity of our large cities.

I commend these speeches to the consideration of you all. I have not hesitated to draw from them largely myself.

I consider this growing realization of the true position which transportation companies occupy, in respect to the public, as one of the most important of recent developments, and it may be well to give it some consideration.

The officers and directors of a street railway company are quasi public officers with most important and serious duties devolving upon them. Their duty to their stockholders is to see that the company is economically and efficiently administered so as to produce a fair return upon the capital invested. Their duty towards the public is to see that the best possible transportation facilities are afforded, having in view "the greatest good of the greatest number." This broad statement of their public duty is unquestionably true, and yet the failure to appreciate this axiom is the most fertile source of adverse criticism of railway management. The critic almost invariably argues from a personal standpoint. If he would only remember that the road is run for the benefit of the masses, and not for his personal individual benefit, the lives of general managers would be made less burdensome.

The last census has clearly shown a strongly marked tendency of our population to gravitate towards the large cities. In every State the percentage of growth in cities is far greater than in towns and villages. Such condensation of population means an increase of the tenement house system in contradistinction to the cottage system, a crowding of people between each roof, an increase in vice, immorality, misery, crime and the death rate. How is it to be avoided? The laborer must live near his work, near in time and near in money. He can spare but a fraction of his time, but a fraction of his day's wages, in going to and from his work. If the zone fare system exists, as in Europe, the area within which he can live is limited by this consideration. Two cents per mile might restrict him to a radius of 2¼ miles (5 cents). If the single fare system prevails, as in this country, time is practically the only restriction. Let us assume that he can allow thirty minutes morning and evening for his car ride, paying five cents for each ride. At the rate of six miles per hour, fast for horses, he has a radius of three miles and an area of 28¼ square miles within which to select a home. At the rate of nine miles per hour, slow for electricity, he has a radius of four and a half miles and an area of 63¼ square miles within which to select a home. This example suffices to illustrate the point. An increase of only three miles per hour in rapidity of transit doubles the available residence area without increasing the time or expense of the laborer in going to and from his work.

The steam road, the elevated road, the undeground road and the cable, each and all afford rapid transit; but their application is restricted within very narrow limits because of their great cost, while the electric roads can be profitably extended in all directions.

The great advantage of increasing the available residence area, of encouraging the cottage system and discouraging the tenement system, will be readily conceded by all. The health and morality of a great city are universally proportional to the number of people beneath each roof. The electric railway is one of the great moral agents of the nineteenth century.

The experience of the past three years has settled many disputed questions, resolved many doubts, systematized methods and improved construction.

A variety of styles, systems and methods were used prior to 1888. We had storage batteries, conduits and overhead wires; single trolley and double trolley wires, over-running trolleys and under-running trolleys.

Storage batteries have made little progress. They have nowhere scored a pronounced success, and have been abandoned on nearly every road. They are but little considered in the field of electric traction, except in reference to future possibilities.

The very few conduits built have disappeared and have been replaced with overhead wires. The overhead wire is now generally recognized as the only practicable method of conveying electricity from the generator to the car motor.

The objections to overhead wires have been, and, in many places still are, very strong; but actual experience has shown that the objections are not well founded. Wires are not an ornament to the street, and objections on this ground will always exist; but lamp-posts, signs, railway tracks, and many other similarly useful objects are not ornaments. Overhead wires will never be condemned on this ground alone. Objections on the score of unsightliness become of less and less importance each year as the methods of construction are improved and the public appreciate more freely the benefits of electric motive power.

One of the early apprehensions in reference to the use of overhead wires was the possible danger to life from the current used. On this point I think the public are now well satisfied. While there are few employés on any of the roads now in operation who have not had the full shock of 500 volts repeatedly, there is not a single instance of any of the patrons of these roads who have been killed or even seriously injured by the 500 volt current from the overhead wire. Electric cars will run over and kill the careless pedestrian or the drunken passenger who falls from the platform in front of the wheels, as will the horse car, but no passenger or pedestrian has ever been killed by the trolley wire, and statistics do not show that the electric car is in any respect more dangerous to life than the horse car or cable car. Last year (1890) the West End street railway system of Boston carried 114,853,081 passengers and all the steam railroads of the whole State of Massachusetts only carried 98,843,712. The West End system killed 15 passengers and employés and the steam roads killed 325. Of the 15 fatal accidents on the West End system five were attributable to electric cars and 10 to horse cars. It is only fair to say that the narrow and crooked streets of Boston and the enormous traffic of the West End system are conditions peculiarly conducive to accidents.

The fear of electric current is one born of ignorance, and time alone can overcome it.

In the year 1889 nine human beings were killed by the arc light wires in New York City (2,500 volts) and the authorities were roused to such a pitch of frenzy that the poles were chopped down and a large part of the city left in darkness. Yet, with perhaps one exception, all of the victims were employés of the lighting companies and suffered because of failure to observe proper and well-known precautions. In the same year 12 persons were asphyxiated by gas and over 30 were killed by signs and other objects falling on their heads as they walked peacefully along the streets.

In time we are able to estimate every danger relatively, but in the beginning unknown dangers, those to which we are not accustomed, are greatly exaggerated.

Ralph W. Pope, in a very interesting paper read before the Franklin Institute last year, gives some curious illustrations of this tendency to magnify unknown dangers and arrest the progress of improvement. I quote:

"In an article, entitled 'How our Ancestors Travelled,' we find the following pertinent observations on the subject:

"Carriages met with great opposition at their first introduction, and laws were made to suppress their use. As early as the year 1294, Philip the Fair, of France, issued an ordinance for suppressing luxury, in which the wives of citizens were forbidden the use of carriages. Beckmann tells us that there is preserved in the archives of the County of Mark an edict, in which the feudal nobility and vassals are prohibited from using coaches under pain of incurring the punishment of felony. Duke John, of Brunswick, published an order in 1588, roundly rating his vassals for neglect of horsemanship, and forbidding them to appear or travel in coaches. A few years after this the English Parliament took up the discussion of the subject, but, on November 7, 1601, the bill to restrain the excessive use of coaches within the realm of England was rejected. But the bitterness of antagonism to them did not cease with this legislative decision. In a pamphlet called the 'Great Concern of England Explained,' published 1673, the writer very gravely attempts to make out that the introduction of coaches was ruining the trade of the realm. Following is an example of his method of reasoning: 'Before coaches were set up travelers rode on horseback, and men had boots, spurs, saddles, bridles, saddle-cloths, and good riding suits, coats and cloaks, stockings and hats, whereby the wood and leather of the kingdom were consumed. Besides, most gentlemen, when they traveled on horseback, used to ride with swords, belts, pistols, holsters, portmanteaus and hat cases, for which in these coaches they have little or no occasion. For when they rode on horseback, they rode in one suit, and carried another to wear when they came to their journey's end; but in coaches they ride in a silk suit, silk stockings, beaver hats, etc., and carry no other with them. This is because they escape the wet and dirt, which, upon horseback, they cannot avoid; whereas, in two or three journeys on horseback these clothes and hats were wont to be spoiled; which done they were forced to have new very often, and that increased the consumption of manufacture.' In another part of his pamphlet, the same writer puts the following query, evidently with the notion that it was a clincher: 'Is it for a man's health or business to be laid fast in four ways; to ride all day with strangers, often times sick, diseased, ancient persons, or young children crying; all whose humors he is obliged to put up with, and crippled with their boxes and bundles?' As an additional objection against the introduction of coaches, the writer urges that they would discourage the breeding and lessen the value of horses.

"The following passage occurs in a protest against the construction of railways, which is preserved in the archives of the Nurnberg Railway at Furth, which was the first line constructed in Germany. It was drawn up by the Royal College of Bavarian Doctors:

"Travel in carriages drawn by a locomotive ought to be forbidden, in the interest of public health. The rapid movement cannot fail to produce among the passengers the mental affection known as *Delirium Furiosum*. Even if travelers are willing to incur the risk, the government should, at least, protect the public. A single glance at a locomotive passing rapidly is sufficient to cause the same cerebral derangement, consequently, it is absolutely necessary to build a fence 10 feet in height on each side of the railway."

"These were all European, however, so in order to assure you that these peculiar views were held in our country, the following protest from the good citizens of Philadelphia, in 1833, against the introduction of gas, will be of interest to you:

"PHILADELPHIA, Nov. 28, 1833.

"REMONSTRANCE AGAINST LIGHTING WITH GAS.

"To the Honorable, the Select and Common Councils of the City of Philadelphia:

"GENTLEMEN—The subscribers beg leave to respectfully remonstrate against the plan now in action for *lighting the city with gas*, as they consider it a most offensive, inexpedient and dangerous mode of lighting. In saying this they are fully sustained by the accounts of explosions, loss of life and destruction of property where this mode of lighting has been adopted.

"We consider gas to be as combustible as gunpowder and nearly as fatal in its acts; as regards the immense destruction of property, we believe that the vast number of fires in New York and other cities may be in a great measure ascribed to this mode of lighting. The leakage of pipes and carelessness of stopping off the gas furnish almost daily instances of its destructive effects. And when we consider that this *powerful and destructive agent* must necessarily be left often to the care and attention of youth and domestics and careless people, we only wonder that the consequences are not more *appalling*. It is also an uncertain light, sometimes suddenly disappearing and leaving streets and houses in total darkness.

"The waters of the Delaware and Schuylkill, now considered the most pure and salubrious in the world, as many long voyages have fully tested, must soon, we fear, experience the deterioration which has reduced the water of the Thames to the present impure state, for no reservoir will be able to contain such fetid drains from such an establishment, and very soon the rivers must be their receptacle, to the destruction of the immense shoals of shad, herring and other fish with which they abound; the same cause must produce the same effect. Salmon, smelts and other fish formerly caught in vast quantities in the Thames, have nearly all disappeared. The constant digging up of the streets, the circumstances of the gas pipes, which, at the intersection of each square, must come in contact with the water pipes are difficulties and evils which we would anxiously avoid.

"In conclusion, we earnestly solicit that the *lighting our city with oil may be continued.*

"And your petitioners, etc.

"Signed by 1,200 of the leading citizens of Philadelphia, whose names are attached hereto, such as Horace Binney, Hartman Kuhn, Jacob Ridgway, Paul Beck, Henry Pratt, Benjamin Chew (on whose farm the battle of Germantown was fought), John Sargeant, Charles Wharton, Richard Willing, Edward Pennington, Robert Baux, Joshua Longstreath, Matthew Newkirk and 1,200 others.

"N. B.—The above are only part of the names as many of the remostrances have not yet come, in."

The double and single trolley system have each had ardent advocates, but three years' experience has decided the question in favor of the single trolley and the ground return.

In July, 1888, several roads were using the overrunning trolley and it was a question whether the over running or under-running system was preferable. Three years have decided this question also, and practically all of the electric roads of to-day operate with under-running trolleys. The "fish pole" of 1888 has been supplanted by the neat steel rod of 1891, and the "broom-stick train" can no longer be spoken of with disrespect as regards outward appearances.

Three years have not passed without much litigation, and already we have historical cases finally determined, which tend to fix the legal boundaries of the rights of electric railways. Some of these decisions are of great importance.

The telephone companies have quite naturally been ardent advocates of the double trolley, and to avoid suffering from the induced currents of the single trolley they have sought to induce the courts to compel railway companies to use metallic circuits. A recent decision of the Supreme Court of the State of Ohio is a fair statement of the present legal aspect of this question.

SINGLE TROLLEY SYSTEM *vs.* DOUBLE TROLLEY.

(Supreme Court of Ohio.)

Syllabus.

1. The dominant purpose for which streets in a municipality are dedicated and opened is to facilitate public travel and transportation, and in that view new and improved modes of conveyance by street railways are by law authorized to be constructed, and a franchise granted to a telephone company of constructing and operating its lines along and upon such streets is subordinate to the right of the public in the streets for the purpose of travel and transportation.

2. The fact that a telephone company acquired and entered upon the exercise of a franchise to erect and maintain its telephone poles and wires upon the streets of a city, prior to the operation of an electric railway thereon, will not give the telephone company, in the use of the streets, a right paramount to the easement of the public, to adopt and use the best and most improved mode of travel thereon; and if the operation of the street railway by electricity as the motive power tends to disturb the working of the telephone system, the remedy of the telephone company will be to readjust its methods to meet the condition created by the introduction of *electromotive* power upon the street railway.

3. Where a telephone company, under authority derived from statute, places its poles and wires in the streets of a municipality, and in order to make a complete electric circuit for the transmission of telephonic messages uses the earth, or what is known as the "ground circuit," for a return current of electricity; and where an electric street railway, afterwards constructed upon the same streets, is operated with the "Single Trolley Overhead System" so called, of which the ground circuit is a constituent part, if the use of the ground circuit in the operation of the street railway interferes with telephone communication, the telephone company, as against the street railway, will not have a vested interest and exclusive right in and to the use of the ground circuit, as a part of the telephone system.

The telephone companies have been beaten in every case, and the fact has been definitely settled that railway companies may use a single overhead trolley wire and a ground return without infringing any rights of the telephone companies.

Many interesting legal questions have arisen in reference to line construction.

Objection was made by the Summer residents of Newport to the construction of an overhead electric railway, and eminent counsel was employed to place every possible legal obstacle in the way. The case was carried to the Supreme Court of the State of Rhode Island for the determination of some of the novel points involved, and one of these points was:

Are Poles and Wires an Additional Servitude upon the Streets?

The Court held:

"The fourth ground alleged is that, if the act of incorporation authorizes the use of electricity for the operation of said street railway, and the erection of the poles as ancillary thereto, it is unconstitutional and void, because it authorizes the imposition of additional servitude upon the streets without providing for any additional compensation to the owners of the fee of said streets. We think it is settled by the greater weight of decision that a railroad constructed in a street or highway and operated by steam in the usual manner imposes a new servitude and entitles the owner of the fee to an additional compensation; but that a street railway operated by horse-power, as such street railways are ordinarily operated, does not impose any new servitude, and does not entitle the owner of the fee to any additional compensation.

"The distinction is not often stated as a distinction between steam and horse railroads; but the distinction properly rests, not on any difference in motive power, but on the different effects produced by them respectively on the highways or streets which they occupy. A steam railway is held to impose a new servitude, not because it is operated by steam, but because it is so operated as to be incompatible with the use of the street in the other usual modes, or, in other words, so as practically to exclude the usual modes of use.

"A steam railroad on a street, so operated as to be consistent with the use of the street in the usual modes, has been held not to impose a new servitude.

"It is not the motor but the kind of occupation, whether practically exclusive or not, which is the criterion.

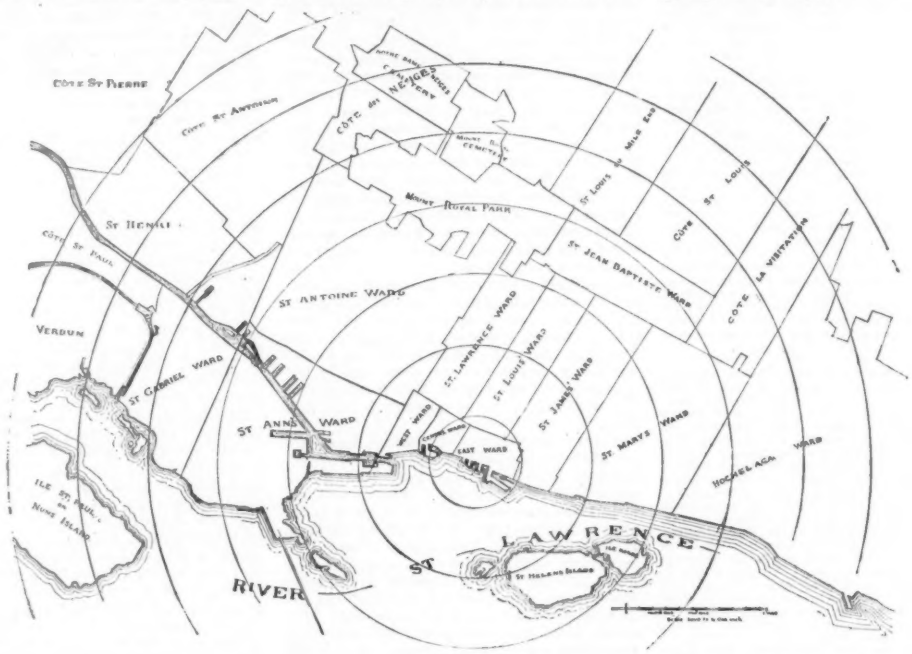
"The only considerable privilege which the horse-car has over other vehicles, is that, being confined to its tracks, it cannot turn aside for other vehicles, while they are forced to turn aside for it; but this is an incidental matter, insufficient to make the horse railroad a new servitude.

"The street railway here complained of is operated neither by steam or horse-power, but by electricity. It does not appear, however, that it occupies the streets or highways any more exclusively than if it were operated by horse-power.

"Reference has been made to cases which hold that telegraph or telephone poles and wires erected on streets or highways constitute an additional servitude, entitling the owners of the fee to additional compensation; and from these cases it is argued that the railway here complained of is an additional servitude, by reason of the poles and wires which communicate its motive power. There are cases which hold as stated, and there are cases which hold otherwise, but, assuming that telegraph and telephone poles and wires do create a new servitude, we do not think it follows that the poles and wires erected and used for the service of said street railway likewise create a new servitude. Telegraph and telephone poles and wires are not used to facilitate the use of the streets where they are erected for travel and transportation, or, if so, very indirectly so; whereas the poles and wires here in question are directly ancillary to the uses of the streets as such, in that they communicate the power by which the street cars are propelled."

In the purely technical field all obstacles have been overcome. Like Perry, "We have met the enemy and they are ours." The severe strain imposed by railway work on the generating plant has necessitated the development of new types of engines, and the fluctuations of the dynamos have been prevented by compound winding and series coils. Self-regulating dynamos are now considered necessary in any well-planned power plant.

I attended the exposition at Bremen, in North Germany, last summer, and had the pleasure of riding on an electric railway operated by two 80



MAP OF MONTREAL, SHOWING APPLICATION OF ZONE SYSTEM, AS MENTIONED IN PRESIDENT HUNTLEY'S ADDRESS.

horse-power Thomson-Houston dynamos. One dynamo was driven by a 70 horse-power Armington & Sims engine and one by a 125 horse-power German engine. So closely did the small American engine regulate that no variation in potential could be observed under the most violent and sudden variations in load. Notwithstanding its greater power, the German engine was slow to respond, and the variations in speed were marked. I was subsequently informed that a medal was awarded to the American engine, although it had not been entered as an exhibit.

This is indicative of the enterprising way in which the inventors and manufacturers of the United States have met the new conditions imposed by the adoption of electricity as a motive power.

The difficulties Mr. Sprague encountered in Richmond in using copper brushes have now been avoided by the introduction of the carbon brush, for which we are indebted to Mr. C. J. Van Depoele.

As early as 1883-4 Van Depoele used carbon brushes with his motors. When the Van Depoele Electric Manufacturing Company was purchased by the Thomson-Houston Company, in 1888, Van Depoele went to the Lynn factory of the latter company. Many did not then consider the carbon brush as practicable, and it was some time before Mr. Van Depoele had an opportunity to demonstrate its possibilities. When the time did come its great value was so apparent that it was at once adopted for motor work and subsequently has been used exclusively with generators.

Since the general adoption of the present method of mounting the motors directly on the axles, double reduction motors have been used. The supposed necessity of high speed of revolution in the armature made this obligatory. In 1890 it was found practicable to make motors in which the armature revolved at a slower rate and a single gear sufficed for the now greatly reduced reduction. From 10 and 12 to 1 with the old motor we come to 4½ to 1 with the new motor. The gears are enclosed in boxes and run in oil so that the noise has been reduced to a minimum, the offensive noise of the gears being practically eliminated. We have also gearless motors with no reduction and no gears.

Generator construction has kept pace with the improvements.

As large stations have been built generators have increased in size, and electrical companies are now producing 500 horse-power dynamos as readily as the steam engine builders respond to similar demands.

We have learned what it costs to operate electric railways and the result is gratifying. In 1888 it was prophesied that while electric roads might make good showings so long as the apparatus was new and curiosity riding lasted, in a short time the machinery would begin to wear out and the roads would be swamped by the great repair bills. In reality we find the almost universal testimony that the longer the road runs the less is the cost of repairs. This is, of course, not due to the fact that the apparatus improves in quality with age, but the explanation is to be found in the very simple fact that as small defects are eliminated and the employés become more experienced and the organization is perfected, the apparatus is better cared for and injuries are prevented.

A very conspicuous example of this is the West End Street Railway, which has been under my own immediate observation.

In the contract between the Thomson-Houston Electric Company and the railway company it was provided that we should keep the overhead line and electrical apparatus on the cars in repair at a given price per car mile. There were many reasons which influenced us to enter such a contract, but the chief reason was that this was the uncertain element in the operation of an electric railway, and unless this uncertainty could be eliminated, the West End would not make any contract. The cost of these repairs has steadily decreased, and on the first of October the West End Company will avail themselves of their option and relieve us of this part of our contract, knowing that there is now no uncertainty and that they can do the work themselves for less money than they pay us.

Some months since President Whitney gave to the public the detailed figures showing the receipts and operating expenses of the West End road. These are of very great interest to all, and I give them in full for the purpose of drawing some conclusions from them:

THE ELECTRIC SYSTEM.

	April.	May.	June.	July.
Gross receipts..	$134,321	$144,638	$153,988	$144,552
General expenses.	8,193	7,796	7,465	6,955
Track and car ex.	47,447	45,443	39,629	43,891
Motive power.....	30,194	30,924	26,359	26,398
Total op. ex.....	85,834	84,163	73,459	77,249
Net earnings.....	48,487	60,475	80,529	67,303
Miles run.....	394,459	376,321	360,567	377,191
Ratio of mileage..	26.68	25.58	25.15	25.19
Per cent. op. ex...	63.36	58.18	47.70	53.44
Earnings per mile run.....	31.05	38.43	42.71	38.32
Ex. per mile run:				
Motive power. ...	07.65	08.22	07.31	07.00
Car repairs.....	01.39	01.33	01.18	01.17
Damages.....	00.75	00.89	00.16	00.12
Conductors and drivers...	07.33	07.36	07.25	06.92
Other expenses...	04.63	04.56	04.47	05.37
Total ex. per mile run.....	21.75	22.36	20.37	20.48
Net earned per mile run.....	12.30	16.07	22.34	17.84

HORSE CAR SYSTEM.

	April.	May.	June.	July.
Gross receipts....	$341,396	$374,605	$395,555	$409,878
General expenses.	22,514	22,682	22,217	20,657
Track and Car ex.	136,693	127,902	125,393	135,954
Motive power.....	117,740	118,972	116,210	116,271
Total op. ex.....	276,947	269,956	263,825	272,888
Net earnings.....	67,449	105,049	131,729	136,990
Miles run.....	1093,887	1094,683	1073,713	1120,377
Ratio mileage.....	73.32	74.42	74.85	74.81
Per cent. op. ex...	80.62	71.95	66.70	66.58
Earnings per mile run.....	31.77	34.22	36.85	36.58
Ex. per mile run:				
Motor power.....	10.86	10.86	10.83	10.38
Car repairs.....	00.93	00.60	00.61	00.61
Damages.....	00.78	00.37	00.15	00.06
Conductors and drivers.....	08.24	08.24	08.25	08.23
Other expenses...	04.70	04.55	04.24	05.07
Total ex. per mile run.....	25.55	24.62	24.58	24.35
Net earned per mile run	06.22	09.60	12.27	12.23

THE ENTIRE SYSTEM.

	April.	May.	June.	July.
Gross earnings....	$478,717	$519,244	$549,543	$554,431
General expenses.	30,707	30,478	29,683	27,613
Track and Car ex.	184,141	173,344	165,027	179,853
Motive power.....	147,933	149,986	142,570	142,670
Total op. ex.....	362,781	353,720	337,284	350,137
Net earnings.....	115,935	165,524	212,259	204,294
Miles run..).....	1478,346	1471,004	1433,785	1497,568
Ratio of mileage..	100	100	100	100
Per cent. op. ex...	76.82	68.12	61.37	63.15
Earnings per mile run.....	32.39	35.29	38.33	37.02
Ex. per mile run:				
Motive power.....	10.01	10.19	09.94	09.53
Car repairs.....	01.05	00.79	00.76	00.75
Damages.....	00.77	00.50	00.15	00.07

THE ENTIRE SYSTEM—CONTINUED.

	April.	May.	June.	July.
Conductors and drivers.....	08.03	08.01	08.00	07.91
Other expenses...	04.68	04.55	04.67	05.12
Total ex. per mile run.....	24.54	24.04	23.52	23.38
Net earned per mile run.....	07.85	11.25	14.81	13 64

Taking the June figures, it will be noticed that the net earnings per electric car mile exceed the net earnings per horse car mile by 10.07 cents, while the operating expenses of the horse car lines exceed those of the electric car lines by 4.20 cents per car mile. The difference is 5.86 cents per car mile, which is the gain to the company due solely to the public satisfaction with the electric service. Mr. Arthur Jones, of the Thomson-Houston International Company, first produced this figure, which he calls the "satisfaction figure."

The net earnings per electric car mile exceeded the net earnings per horse car mile by the following amounts:

In April, 6.08 cents per car mile.
" May, 6.47 " " "
" June, 10.07 " " "
Mean 7.54 " " "

The net earnings of the horse cars for the three months averaged 9.36 cents per car mile, hence the electric cars showed a gain of 80 per cent. in the net earnings per car mile over the horse cars.

For the three months we have the following figures for the electric cars:

Total receipts.....	$432,947
" expenses..... ...	243,456
Percentage of expenses to receipts.	56%

In St. Paul and Minneapolis, with a combined population of 350,000, there is to-day not one single horse car. Minneapolis has 120 miles of electric railways, all equipped with the overhead system, and St. Paul has 75 miles of electric railways and 15 miles of cable. Most of the cable mileage is to be abandoned and supplanted by electricity. The last horse car disappeared from the streets of Minneapolis in June of this year. The July report of the Minneapolis system shows:

Gross earnings.....	$107,571
" expenses...	52,585
Net earnings.....	54,985
Percentage of expenses to receipts.	49%

Cleveland, Buffalo, Rochester, Toledo, Omaha, Cincinnati and many other large cities, are now operating their street cars almost exclusively with electric motors, and the universal testimony is favorable to the increased facilities afforded the public and the increased profits to the stockholders.

Not the least important of the developments of the last three years has been the financial development. The fine showings as to earnings, the gradual decrease in operating expenses, where increases were expected, the oft-demonstrated ability to run electric cars in all kinds of weather, in ice, snow, sleet, hail or rain, has greatly improved the standing of electrical securities. An electric road is no longer an experiment, it is a paying investment, and there are not a few instances where the introduction of electricity has been the salvation of a horse road that otherwise would have soon been in the hands of a receiver. The rapidly increasing demand for electrical securities is an evidence of a healthy growth of public sentiment in this direction. To equip electrically means the expenditure of money which must come from an increase of the bond of stock issued. The ability of the public to rapidly absorb these new bonds of stocks must be the ultimate limit of the ability of the railway companies to move in this direction.

In August the West End Street Railway Company put out $4,000,000 of common stock for additional electrical equipment, under a plan of subscription which provided for two deferred payments. When the subscription books were closed on August 5, 33,000 shares had been paid in, and only a paltry 245 shares had taken advantage of the option for deferred payments. I know of no more striking object lesson than this, except, perhaps, the rapid rise of the West End common stock from 63 to 77, which immediately followed.

Electric securities have heretofore been offered at tempting figures, but the day for this is passing. The public are realizing that a good street railway security is better than a Western railroad bond or stock, and the electric roads are better than the horse roads. Electric railways will pay where no one would dream of building a horse road, and when the public taste is whetted for electrical securities we shall see a marvelous increase in the number of roads and the equipment of existing roads that will mean transportation facilities for thousands who are now unprovided, and many years' work for our electrical factories.

The President: This paper is before you for discussion. Are there any remarks?

Mr. Hammer: This is an admirable paper, and contains a number of chronological events which deserve to go on record, but I think that some have been omitted. To say nothing of the experiments of Dr. Siemens, whose railroad is still running in Berlin, and which dates away beyond any that Captain Griffin has referred to, I might refer to the experiments made in 1881 in Paris at the time of the electrical exposition. I believe the date given as the earliest, in this paper, was 1883. I have a very vivid recollection of an electric railroad which was in operation in 1880 and 1881, a mile and a half in length, at Menlo Park, and which attained a speed of no less than 40 miles per hour, and within a very short time after that was extended to three and a half miles in length. It was such an elaborate experiment at that time, and of such great commercial value, that I think the fact should be put on record in connection with a paper of the importance that this is.

Mr. Griffin: I would like to say, with reference to early experiments which I have referred to, that I did not intend that the list should be taken as complete. Perhaps I did not express it explicitly, but I intended to confine it simply to the United States. The car I refer to, on the Cleveland road—I intended to make that explicit—was the first car I knew of that was in operation upon any existing street railway on the streets of a city as an existing road. There were lots of experimental roads which were built in addition to those that I have mentioned, that were built for the purpose of demonstrating the feasibility and the possibility of operating street railways by electricity, but I think that that car in Cleveland was the first car that was put into operation upon an existing street railway upon the streets of a city and put in schedule operation. That may be a small distinction, but such as it is, it is one which Mr. Bentley and Mr. Knight have always delighted to make a great deal of.

Mr. Armstrong: I believe that at the present time I represent a corporation, and possibly the only one that is a member of this Association, that operates a street railroad by electricity. While I am president of the Camden Lighting and Heating Company, I am also the accredited representative of the Camden Horse Railway Company, which operates one of its lines by electricity, and our Camden Lighting and Heating Company furnishes the power for that operation. I have been very much interested in this paper by Captain Griffin, and I could not help recalling the first time I saw Captain Griffin. We were just then thinking about putting in, or had contracted to put in, an electrical system, and I was, with the president of our horse railway company and some other friends, at Washington. We had gone down there to help inaugurate a president. We were riding on the top deck of one of those double-deck cars, and we were trying to show how much we knew about electricity. There was a fine-looking, large man standing around there who did not seem to know much about it, or at least did not have very much to say, until we got stumped, and then he came to our assistance, and the more he talked the more we found that we knew about this subject. When he got through he handed us his card, and we then found that we were talking with a man who was most deeply interested in this subject, and who knew the most about it. Ever since that time Captain Griffin's name has been associated with street railways in my mind, and in that of many others in their recollections of him. I want to say, so far as the experience that we have had is concerned, that the very fact of operating our lines by electricity has brought us large additional travel. Not because we make better time (because we run exactly on the same schedules as we did with horses), not that our cars are any more comfortable, but seemingly from the very fact that there is a motive power there which requires the expenditure of no life whatever. There is no drawing on that thing that we cannot understand, and never will be able to understand—either in man or beast—there is no draught made upon the eternal principle of life there, but by some intangible force we are pushing along. The people do not find that they go faster, and there is no more of comfort in it, except the satisfaction of knowing that your comfort and your ease is not purchased at the cost of the discomfort or the dissatisfaction of anything else that lives.

There is one thing with which I am not yet able to agree in Captain Griffin's paper—possibly later experience may lead me to agree with his statement. That it will pay to put down an electric road where a horse road would not pay. So far as my observation is concerned, I cannot bear out that statement, because you can surely operate a horse railroad at less expense by running fewer cars, than you can possibly operate an electric road where you have to have your steam plant and your power for producing electricity all the time ready. If you are operating on a 15 minutes or half hour schedule on street cars, you do not have to do that thing to the same extent. In that respect I cannot go so far as he does in his paper. But under given conditions, where the travel can reasonably be kept at a fair schedule, that may be, and perhaps is, true. Our experience is that it pays us only because we carry so many more people than we did when we were operating by horses.

Dr. Bell: I had occasion last year to look into this very question with a good deal of care, and, in answer to my inquiries, I received replies from considerably over one hundred roads, with reference to the effect of a motive power on the traffic, and on the actual operating expenses. The result of the experience detailed in these replies, (and they were representatives from all the well known systems) was singularly uniform. In the statement that there had been a great increase in traffic varying from 3 per cent. to 300 per cent., following the change from horses to electricity, whereas the actual expenses (although formerly greater with electricity than with horses) were much less in proportion to the traffic with electricity than with horses, and that, furthermore, very frequently a real decrease in the running expenses was observed. I think that there are certain classes of roads which are operated every day by electricity that never could be profitably operated by horses—and that is roads on grades that are far too severe for successful regular operation with horses, and which at the same time run through regions too sparsely settled to permit of surmounting grades by cables. There is a very considerable field of that kind which cannot be operated except by electricity. We are now operating in many places 10 to 12 per cent. grades, and operating under circumstances where it would be almost impossible to handle cars by any amount of horse power that you could get on the street. It is in these special cases that the advantages are most manifest, although I think to-day experience shows that in a system of anything like decent size the actual running expenses per car mile are quite a little less with electricity than with horses. Of course, on the great West End system, that is very marked indeed. Of course, that location is specially favorable. But the balance is, I think, in at least one-half the cases that I have been able to get information about, in favor of electricity in the line of expense—the total expenses per car mile—quite aside from the question of increased travel.

The President: If there is no further discussion on the paper just read, we will proceed with the programme. Before taking up the next thing in regular order I will read the following telegram with reference to the census statistics which are being gathered with reference to the applications of the science which we represent here:

Mr. Allen R. Foote: All investigations in charge of expert special agents have been postponed until after the meeting of Congress. All agents have been dropped, including yourself. Letter by mail.

That is looking forward to dropping the idea of gathering together a lot of valuable statistics, right at the time when we are in the middle of it. Since that telegram was received the letter has also arrived, and, I think, has been handed to Dr. Mason, who will give us further information in relation to it, and will give us some suggestions.

Dr. Mason: You will remember a year ago in our meetings resolutions were introduced relative to a committee on legislation, and a motion was then made, and secured the assent of this body, urging Congress to make an appropriation in support of the movement to take a thorough census on the electrical industry. A bill which had been introduced in Congress, having this object in view, was urged, but at the last moment, in the pressure of business, the matter was passed over, and no appropriation has ever been made for taking the census of the electrical industries. Some $15,000, which had been already expended, have been taken from wherever he could get the money by General Porter, all the time hoping that they could get on in that way until an appropriation could be secured by Congress. But in the confusion with regard to census matters, General Porter has found himself obliged to take the action stated in this telegram, and followed up by the letter, which, perhaps, it is not necessary that I should read to you further than to say that, in view of the facts in the case, he states that it does not seem practicable for him to continue furnishing the funds as he has been doing, without a special appropriation. In this letter he looks to the retaking up of the work on the part of Mr. Foote when proper appropriations shall have been secured. It seems to me of the utmost importance that at the present meeting this Association should take definite action looking to the securing of the appropriation which was asked for a year ago, and which should have been granted at the session of Congress then being held. Personally, I feel that Congress has been guilty of an absurdity. Look at the statistics which have been brought us here in the last hour relative to the applications of electricity as motive power in matters of traction. Look at what has been done in the past two years—and no statistics being gathered, no record being made in this census of the work of the last ten years particularly, all along the various branches of applied electricity. It is now proposed that this shall be dropped, that there shall go on the record with the census of 1890 no mention of electricity. The thing is absolutely absurd. It seems to me that, if properly presented to Congress at its next meeting, proper action may be had. But, in the meantime, what shall be done? In the meantime $15,000 has been already expended, and yet the work falls to the ground, unless it is carried directly forward now. I doubt whether it can be laid down and taken up again. It should go on now, and some provision should be made by the Secretary of the Interior, if the Commissioner of Census cannot attend to it himself, and he has no means at his disposal, then some special provision should be made by the Secretary of the Interior which will enable this work to go right on from day to day. There is no propriety in having any hiatus. Feeling as I do upon this point, and feeling that we would stand before the world in a most unenviable light if this matter were dropped, I beg to offer the following:

Whereas, The Hon. Robert P. Porter, Superintendent of the Eleventh Census, has authorized the collection of the statistics of the electrical industries, and has appointed Mr. Allen R. Foote, Special Expert Agent for that purpose; and

Whereas, Mr. Foote has prepared schedules for the collection of such statistics covering nearly every known practical use of electrical energy; and

Whereas, These schedules provide for information of great public value that is imperatively demanded for the intelligent discussion and settlement of questions of grave public importance; and

Whereas, This Association is advised that the work undertaken is in danger of being delayed, if not altogether abandoned, by reason of insufficient appropriation, thus utterly wasting the $12,000 or $15,000 already expended, and, what is of far more serious moment, depriving the people of the benefits derived from a report that there is reason to believe

would be a thorough and reliable authority on the subjects of which it treats,

"Therefore, be it *Resolved*,

"1. That this Association respectfully requests the Hon. Robert P. Porter, Superintendent of Census, or, if he is not sufficiently empowered, the Hon. John W. Noble, Secretary of the Interior, to provide for the carrying to the earliest possible completion of the work so well begun.

"2. That immediately upon the convening of the 52d Congress the Executive Committee of this Association be directed to secure the re-introduction of Senate Bill No. 4329, of the 51st Congress, appropriating $50,000 for the special work under Mr. Foote's direction, and to use all proper means to secure its passage at the earliest possible date.

"3. That this Association hereby expresses its approval and high appreciation of the work Mr. Foote has done in his official capacity as Special Agent of the Eleventh Census for the collection of the statistics of the electrical industries and its belief that the reports he may prepare, if enabled fully to carry out his plans therefor as shown by the schedules submitted by him for examination, will have a value equal to that of the most valuable reports ever issued by the United States government.

"4. That the President and Secretary of this Association be directed to at once forward a certified copy of these preambles and resolutions to the Hon. John W. Noble, Secretary of the Interior, the Hon. Robert P. Porter, Superintendent of Census, and Allen R. Foote, Special Agent for the Eleventh Census, at Washington, D. C."

I desire to say, in addition, that I hold in my hand a gathering together of the various schedules which Mr. Foote has prepared in his foundation work for the gathering of the information needed with regard to matters connected with electricity, and I have examined them with a great deal of care. I do not consider myself competent to pass judgment upon them, but I will say this, as one who has had something to do with statistics, that it is the most complete of any that I have ever seen. I hope that this matter will not end with this Association, but at the convention of the Street Railway Association similar resolutions may be passed, and that action may be taken by all other associations who are interested in kindred matters. I now offer the resolutions which I have read.

Mr. Armstrong: I gladly second those resolutions, but I think that we ought to go further than that. I particularly appreciate what Dr. Mason has referred to, as to our stopping the work that has now been begun. A delay of six months is a most serious thing for us. Why? Because we are trying to gain information which will enable us to make great strides in advance in the next six months. That is the reason why we have been having conventions twice a year. I apprehend that the reason why this work is permitted to lag is largely because it is not understood. I feel that the matter is of sufficient importance to make it advisable for us to have a committee headed by such a man as Dr. Mason to go to Washington. I trust that Dr. Mason will add to his resolutions that a committee of three or of five members be appointed by this body to present the resolutions, and that they go to Washington and at once present them to the Superintendent of the Census, to the Secretary of the Interior, and, if it be necessary, to the President himself, in order that direction may be given for the continuance of this work. There is enough of interest in the work for us; there is enough involved in it for us as an Association to assume all the expense, and to take all the time necessary to be expended and to make all efforts that may be required to accomplish this work and prevent its being dropped for a month or for a week. (Applause.)

Mr. Francisco: I fully agree with Judge Armstrong in the position he has taken with regard to this question. I have had occasion during the last year, in a matter which I have had in hand regarding statistics, to draw heavily upon the Census Department, and have received very valuable information which has been gathered as has been illustrated here. I hope and trust that this matter will be pushed vigorously, and that, as Judge Armstrong says, this Association will take it up and carry it forward immediately. I would offer, as an amendment to Dr. Mason's resolutions, that the President appoint a committee as Judge Armstrong suggests, and that Dr. Mason be made chairman of that committee. (Applause.)

Dr. Mason: It is evidently the sense of the meeting that something of this sort should be offered, and I will offer this now, if you will allow me. I move that a committee of three members of this Association be appointed, whose duty it shall be to carry the resolutions to Washington. First, as I have made an offer of the resolutions, perhaps, I had better wait, and then, after they have been adopted, I will offer such a motion as I have indicated.

The President: This preamble and resolutions, as prescnted by Dr. Mason, are now before you. What is your pleasure?

Mr. Armstrong: I ask that the resolutions be adopted by a rising vote.

(The resolutions were unanimously adopted.)

Dr. Mason: I will now introduce the motion that I had in mind:

Resolved, That a committee of five members of the National Electric Light Association be appointed who shall carry to Washington the preamble and resolutions just adopted, present the same to the Honorable the Superintendent of Census; the Honorable the Secretary of the Interior, and, if desirable to the President of the United States, and urge the necessity of the continuance, without a day's delay, of the work of Special Agent Foote.

Mr. Francisco: I second the motion.

The President: I would suggest that a committee of three would answer as well, could present the resolutions as forcibly, and would have as much weight in presenting them as would a committee of five.

Mr. Armstrong: If we have a committee of five, it may be that but three will attend. In my experience five would be better than three. I hope that the whole five will go.

(The resolution was unanimously adopted.)

Dr. Mason: May I be permitted to present another resolution which ought to come up now for action in connection with what has just been done:

Resolved, That the Association request the cooperation of other electrical associations and societies, also all associations or societies directly or indirectly interested in the subject, in measures to secure the carrying to completion of the census work commenced by Special Agent Allen R. Foote, for the collection of statistics of the electrical industries.

Mr. Francisco: I second that resolution.

(The resolution was unanimously adopted.)

The President: On Monday the Committee on Safe Wiring made their report, which was received and ordered printed, and that the matter be taken up at the earliest possible moment after the printed copies were received for distribution. The copies are here and the matter now properly comes up for discussion.

Dr. Mason: In order to facilitate business here, I want to call attention to the last words in the recommendation attached to the report of the Committee on Safe Wiring—for I prefer to call the committee by that name. I call your attention to the resolution which was offered by the committee:

"That a committee of five be appointed by the president, to be a permanent committee on safe methods of construct on and operation—any vacancies that may occur on the committee, from time to time, to be filled by the President."

I move the adoption of that resolution. If that motion is seconded, I wish to make some remarks.

Mr. Armstrong: I second the motion.

Dr. Mason: I have made this motion at the initial stage of the consideration of this report for the reason that whatever we may do with this report we need such a committee, and, in the second place, because there has been a great deal of honest and earnest work done by this committee, and we cannot but appreciate its value. But, at the same time, neither this committee nor any other committee have presented to us a full report on this matter, with rules which would be satisfactory to all of us, and probably they could not be presented until we had obtained the sanction of a majority of the Association to them in every particular. There are certain things about this report which seem to me, if I may be allowed in that way to criticise it, to be absolutely absurd, as, for instance, when the committee commence with the statement that they "have formulated certain preliminary requirements which they think essential to safe wiring," and then say, "these must not be considered as rules to be absolutely followed." Now, gentlemen, if we are to have rules that are absolutely essential to safe wiring, but which are not to be absolutely followed, why, then, let us stop work. I think that we ought to have adopted by this Association certain rules which shall govern, so far as we can control the future, all installations, or, rather, all installations in the future, and control them absolutely. If, with the co-operation of all the insurance men, and of all the electrical engineers, and the expression of the wisdom of our own members, we cannot make such rules, then we ought to be ashamed of ourselves. I do not think we should adopt anything which we will not consider should be absolutely followed, but what we say should rather be in the nature of suggestions as to the line upon which each local association may form its own rules in detail, independently. Let us make rules, and let us make rules to be followed, and let us ask that they shall be followed.

Mr. Nicholls: I quite agree with the desire expressed by Dr. Mason to have the Association adopt a code of rules, but will it not be necessary, before we can adopt and enforce those rules, to have the insurance authorities agree with us as to the rules in detail?

Mr. Francisco: I will simply say, with regard to this insurance business, that I am a member of the insurance fraternity of the United States, and from the knowledge that I have I am able to state that 15 States have already practically adopted these rules as they appear here, and the New England Insurance Exchange will adopt them. When you have such a man as Captain Brophy, who has been on the road examining electric light plants for years, on a committee of this kind, and he has devoted his time and contributed his experience in devising the rules, you may depend upon it that you have got something that you can stand on.

Mr. Armstrong: I would like to inquire of Dr. Mason, of Mr. Francisco, or of Captain Brophy whether it would not be possible to go a little further than the committee has done here in this resolution, and to have this whole matter placed in their charge? I understand that with the general scheme Dr. Mason is entirely satisfied. Let us, therefore, adopt it as a general scheme just as the matter now stands.

Dr. Mason: I think that I have failed to make myself understood. The motion which I have made is simply to adopt a certain resolution; but, if you will allow me, I will answer these points now in order to make it clear. My point was exactly that which Judge Armstrong presents. I say, let us adopt absolutely what you can, and deny nothing, but simply refer to the new committee matters in respect to which we are in doubt in order that they may do just what we have said. Now, it is no use for us to consider what the insurance people say. We settled it a year ago that we did not care a fig what the insurance men might say, for we know more than they do about certain things. I say "we," for I am as largely interested as any of you in electric light and power plants. No matter what the insurance men may say, we do not wish to adopt rules which do not approve themselves to us. We settled it a year ago that we would do this thing independently, after securing, as far as we might, all the wisdom there was in them. I want you to understand, Mr. President, that I desire to have the majority of these rules adopted and made absolute—not adopted tentatively, but adopted absolutely—and that everything on which we have serious doubt be referred back to the committee for their further consideration. I believe that Captain Brophy and every other member of the committee, if they will give me five minutes, will be convinced that they have made grave mistakes in respect to some of these rules. I call for the question on the adoption of that resolution.

Mr. Francisco: The insurance companies insist upon certain conditions. If you don't comply with what they consider essential conditions, you will get into trouble. Now, the insurance people have conferred with this committee and they have practically approved these rules. By adopting them, you not only secure the adoption by these insurance associations of your own committee's rules, but you make a harmonious thing through the whole field.

Mr. Armstrong: May I rise to what is hardly a question for information nor a point of order, but Dr. Mason has made the point here that these rules are not to be absolutely followed, but are really tentative rules. I want to be informed by the committee whether, if we adopt these rules, we make them absolute rules or make them as rules which we may use or not, just as we please.

The President: I thought you were going to raise a point of order. The question before the house is on the adoption of the resolution recommended by the committee—that a committee of five be appointed for future action relative to the safety of wires. That motion has nothing whatever to do, as I understand it, with the adoption of these rules by this Association. We have received the report of that committee, but we are making no disposition of the report of the committee as yet, as I understand this resolution.

(The resolution was adopted.)

The President: Now you have before you, as I understand it, the report of the Committee on Rules for Safe Wiring, and it is for you to signify your pleasure in the matter. It seems to me, that while we all have confidence in our committee, still, I do not think there are any of us who want to adopt these rules without first having an opportunity to go through them in detail. As suggested by Dr. Mason, it will take a good deal of time to go through them in detail in this convention, but I can see no harm in receiving the report, permitting the thing to stand as it is, and making it a special order of business for the next meeting of the convention.

Mr. Armstrong: Is it at all necessary, under the resolutions that we have already adopted, to do anything at all? We have appointed a committee, which committee is to be the arbitrator of rules for safe wiring. I take it that it would be a waste of time for us even to attempt to adopt these rules, and I am sure it would not be a mark of wisdom for a popular convention, as this is, to undertake to adopt these rules. We have now resolved to appoint a committee which will be a permanent committee on safe methods of construction and operation. Within a year these rules in many essential points may be absolutely changed. I know that in our station we have had to throw out things which a while ago were recommended as important or essential, and the things now adopted may soon have to be changed for something else. So, while these rules may stand as suggestions coming from the committee, it would be inadvisable to adopt any of them absolutely.

Mr. Mason: If we do not do something, what do we do? We throw this matter into the hands of other people. There are rules here which I declare to you are absolutely absurd, and I cannot understand how they could have passed this committee. What are we to do with them? Are we to leave ourselves to be bound by rules which we cannot approve? In what position, as members of the National Electric Light Association, do we stand?

Mr. Armstrong: I move that we resolve ourselves into a Committee of the Whole upon this matter, so as to dispose of it speedily, and without taking time to make a record of what is done, except to report as a Committee of the Whole, and then we can dispose of the whole matter.

Mr. Mason: I second the motion.

(The motion was agreed to and the convention formed into Committee of the Whole for the consideration of the report of the committee.)

The Committee of the Whole reported the rules in the following form, which was adopted by the convention:

Report of Committee on Tabulating, Wiring and Insurance Rules.

Class A.—Central Stations for Light or Power.

These rules also apply to dynamo rooms in isolated plants, connected with or detached from buildings used for other purposes. Also to all varieties of apparatus, of both high and low potential.

Generators or motors must be:

1. Located in a dry place.
2. Insulated on floors or base-frames, which must be kept filled to prevent absorption of moisture, and also kept clean and dry.
3. Not exposed to flying or combustible materials.
4. Each covered with a waterproof cover when not operating.

In no case must a generator be placed in a room where any hazardous process is carried on, such as the working room of a cotton, jute, flax, woolen or flour mill.

Care and Attendance.—A competent man must be kept on duty in the room where generators are operating. Oily waste must be kept in metal cans and removed daily.

Conductors from generators, switchboards, rheostats or other instruments, and thence to outside lines, must be:

1. In plain sight.
2. Wholly on non-combustible insulators, such as glass or porcelain.
3. Separated from contact with floors, partitions or walls through which they may pass, by non-combustible insulating tubes.
4. Kept rigidly so far apart that they cannot come in contact.
5. Covered with non-inflammable insulating material sufficient to prevent accidental contact.
6. Ample in carrying capacity to prevent heating. (See Capacity of Wires Table.)
7. Connected by splices or joints equal in carrying capacity to the conductors themselves, soldered, if necessary, to make them efficient and permanent.
8. When under floors or in distributing towers, placed in spaces ample for inspection and ventilation, and provided with special insulating covering.

Switchboards must be:

1. So placed as to make it impossible to communicate fire to surrounding combustible material; accessible from all sides when the connections are on the back; or may be placed against a brick or stone wall when the connections are entirely on the face.
2. Kept free from moisture.
3. Made of non-combustible material, or of hard wood, filled to prevent absorption of moisture.
4. Equipped with bars and wires in accordance with rules 1, 2, 4, 5, 6 and 7, for placing conductors.

Resistance boxes and equalizers must be:

1. Equipped with metal or non-combustible frames.
2. Treated as sources of heat.
3. Placed on the switch or a distance of a foot from combustible material, or separated therefrom by asbestos or cement.

Lightning arresters must be:

1. Attached to each side of every overhead circuit connected with the station.
2. In plain sight.
3. On the switchboard or in an equally accessible place, away from combustible material.
4. Connected with at least two earths by separate wires of large size.
5. So constructed as not to maintain an arc after the discharge has passed.

Testing—All series and alternating circuits must be tested every two hours while in operation to discover any leakage to earth, abnormal in view of the potential and method of operation.

All multiple arc low potential systems (300 volts or less) must be provided with an indicating or detecting device, readily attachable, to afford easy means of testing where the station operates perpetually.

Data obtained from all tests must be preserved for examination by insurance inspectors.

Class B.—Arc (Series) Systems.

Overhead conductors—All outside overhead conductors (including services) must be:

1. Covered with some insulating material not easily abraded.
2. Firmly secured to properly insulated and substantially built supports, all the wires having an insulation equal to that of the conductors they confine.
3. So placed that moisture cannot form a cross-connection between them, not less than a foot apart and not in contact with any substance other than proper insulating supports.
4. At least seven feet above the highest point of flat roofs and at least one foot above the ridge of pitched roofs, over which they pass or to which they are attached.
5. Protected whenever necessary, in view of possible accidents to conductors or supports, from possibility of contact with other conducting wires or substances to which current may leak, by *dead insulated guard irons or wires*. Special precautions of this kind must be taken where sharp angles occur, or where any wires might possibly come in contact with electric light or power wires.
6. Provided with petticoat insulators of glass or porcelain. Porcelain knobs and rubber hooks are prohibited.
7. So spliced or joined as to be both mechanically and electrically secure without solder. They must then be soldered to insure preservation and covered with an insulation equal to that on the conductors.

The following formula for soldering fluid is approved:

Saturated solution of zinc	5 parts.
Alcohol	4 parts.
Glycerine	1 part.

Conductors should not be run over or attached to buildings other than those in which light or power is being, or is to be, used, but on separate poles or structures always easily inspected.

Service blocks must be covered over their entire surface with at least two coats of waterproof paint and so maintained.

Telegraph, telephone and similar wires must not be placed on the same arm with electric or power wires, and *should not* be placed on the same structure or pole.

INTERIOR CONDUCTORS.

All interior conductors must be:

1. Where they enter buildings from outside terminal insulators to and through the walls, covered with waterproof insulation, and must have drip loops outside, preferably slanting upward toward the inside and bushed with waterproof and non-combustible insulating tube.

2. Arranged to enter and leave the building through a double contact service switch, which will effectually close the main circuit and disconnect the interior wires when it is turned "off." The switch must be so constructed that it shall be automatic in its action, not stopping between points when started, and prevent an arc between the points under all circumstances; it must indicate on inspection whether the current be "on" or "off," and be mounted on a non-cumbustible base in a position where it can be kept free from moisture, and easy of access to police or firemen.

3. Always in plain sight, never covered, except in special cases, where an armored tube may be necessary.

4. Covered in all cases with a moisture-proof, non-combustible material that will adhere to the wire, not fray by friction, and bear a temperature of 150 degrees Fahr. without softening.

5. In dry places, kept rigidly apart at least 10 inches except when covered (in addition to insulation) by a moisture-proof non-conducting, non-inflammable tubing, which must be strong enough to protect the insulating covering from injury. Conductors thus placed may be run not less than three inches apart, and be fastened with staples, under which are placed mechanically rigid insulating strips or saddles of greater width than the metal of the staple, by which possibility of injury to the tube may be prevented.

6. In damp places, attached to glass or porcelain insulators, and separated 10 inches or more.

7. When passing through walls, floors, timbers or partitions, treated as in central stations under like conditions.

LAMPS AND OTHER DEVICES.

Arc lamps must be in every case:

1. Carefully isolated from inflammable material.

2. Provided at all times with a glass globe surrounding the arc, securely fastened upon a closed base. No broken or cracked globes may be used.

3. Provided with a hand switch, also an automatic switch, that will shunt the current around the carbons, should they fail to feed properly.

4. Provided with reliable stops to prevent carbons from falling out in case the clamps become loose.

5. Carefully insulated from the circuit in all their exposed parts.

6. Where inflammable material is near or under the lamps, provided with a wire netting around the globe and a spark-arrester above, to prevent escape of sparks, melted copper or carbon.

Incandescent lamps in series circuits, having a maximum potential of 350 volts or over, must be governed by the same rules as for arc lights, and each series lamp provided with a hand switch and automatic cut-out switch; when lights are in multiple series, such switches and cut-outs must not control less than a single groups of lights. Electro-magnetic devices for switches are not approved.

Under no circumstances will incandescent lamps on series circuits be allowed to be attached to gas fixtures.

CLASS C.—INCANDESCENT (LOW PRESSURE) SYSTEMS, 300 VOLTS OR LESS.

OVERHEAD CONDUCTORS.

Outside overhead conductors must be:

1. Erected in accordance with general rules for arc (series) circuit conductors.

2. Separated not less than six inches, where they enter buildings as service conductors, and be provided with a double pole fusible cut-out, as near as possible to the point of entrance to the building, and outside the walls when practicable.

UNDERGROUND CONDUCTORS.

Underground conductors must be:

1. Provided with suitable protecting devices at the ends of tube or conduit services inside the walls of buildings, as a guard against moisture and injury.

2. Terminated at a properly placed double pole house cut-out.

3. Of specially insulated conductors after leaving the tube or conduit, and separated by at least ten inches, until the double pole cut-out is reached.

INSIDE WIRING.

Wire should be so placed that in the event of the failure or deterioration of their insulating covering the conductors will still remain insulated.

At the entrance of every building there shall be a double pole switch placed in the service conductors, whereby the current may be entirely cut off.

Conductors must not be:

1. Of sizes smaller than No. 16 B. & S., No. 18 B. W. G., or No. 3 E. S. G.

2. Lead or paraffine covered.

3. Covered with soft rubber tube.

4. Laid in mouldings of any kind in damp places.

5. Laid in mouldings, with open grooves, against the wall or ceiling.

6. Laid in mouldings where less than half an inch of solid insulation is between parallel wire and between wires and walls of ceilings.

Mouldings, where admissible, must have at least two coatings of waterproof paint to be impregnated with a moisture repellent.

Cleat work is not desirable, and cleats must *not* be used unless:

1. In a very dry place.

2. In a place perfectly open for inspection at any time.

3. They are of porcelain, or well-seasoned wood, filled, to prevent absorption of moisture.

4. They are so arranged that wires of opposite polarity, with a difference of potential of 150 volts or less, will be kept at least two and one half inches apart, and that where a higher voltage is used this distance be increased proportionately.

5. There is a backing provided, of wood, at least half an inch thick, well seasoned and filled, to prevent absorption of moisture.

Staples must never be used to fasten conductors, unless:

1. Provided with an insulating sleeve or saddle rigidly attached to the metal of the staple and having such strength and service as to prevent mechanical injury to the insulation of the conductor.

2. Under conditions in which cleat work would be acceptable or where driven into a moulding specially adapted for open work.

SPECIAL WIRING.

Wherever conductors cross gas, water, or other metallic pipes, or any other conductors or conducting material (except arc light wires), they should be separated therefrom by some continuous non-conductor at least one inch. In crossing arc light wires the low tension conductors must be placed at a distance of at least six inches. In wet places an air space must be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run over all pipes upon which condensed moisture is likely to gather, or which, by leakage, might cause trouble on a circuit.

In breweries, stables, dye-houses, paper and pulp mills, or other buildings specially liable to moisture, all conductors, except where used for pendants, must be:

1. Separated at least six inches.
2. Carefully put up.
3. Supported by porcelain or glass insulators.

Moisture proof and non-inflammable tubing may be accepted in lieu of such construction.

No switches or fusible cut-outs will be allowed in such places.

Interior conduits must not be:

1. Combustible.
2. Of such material as will be injured or destroyed by plaster or cement, or of such material as will injure the insulation of the conductor.
3. So constructed or placed that difficulty will be experienced in removing or replacing the conductors.
4. Subject to mechanical injury by saws, chisels or nails.
5. Supplied with a twin conductor in a single tube where a current of more than 10 amperes is expected.
6. Depended upon for insulation. The conductors must be covered with moisture-proof material.

The object of a tube or conduit is to facilitate the insertion or extraction of the conductors, to protect them from mechanical injury, and, as far as possible, from moisture.

Twin tube conductors must not be separated from each other by rubber or similar material, but by cotton or other readily carbonizable substance.

Conductors passing through walls or ceilings must be incased in a suitable tubing, which must extend at least one inch beyond the finished surface until the mortar or other similar material be entirely dry, when the projection may be reduced to half an inch.

Double pole safety cut-outs must be:

1. Placed where the overhead or underground conductors enter a building and join the inside wires.
2. Placed at every point where a change is made in the size of the wire (unless the cut-out in the larger wire will protect the smaller). This includes all flexible conductors. All such junctions must be in plain sight.
3. Constructed with bases of non-combustible and moisture-proof material.
4. So constructed and placed that an arc cannot be maintained between the terminals by the fusing of the metal.
5. So placed that on any combination fixture, no group of lamps requiring a current of six amperes or more shall be ultimately dependent upon one cut-out.
6. Wherever used for more than six amperes, or (where the plug or equivalent device is not used) equipped with fusible strips or wires provided with contact surfaces or tips of harder metal, soldered or otherwise, having perfect electrical connection with the fusible part of the strip.

Safety fuses must be so proportioned to the conductors they are intended to protect that they will melt before the maximum safe carrying capacity of the wire is exceeded.

All fuses, where possible, must be stamped or otherwise marked with the number of amperes equal to the safe carrying capacity of the wire they protect.

All cut-out blocks when installed must be similarly marked.

The safe carrying capacity of a wire changes under different circumstances, being about 40 per cent. less when the wire is closed in a tube or piece of moulding than when bare and exposed to the air, when the heat is rapidly radiated. It must be clearly understood that the size of the fuse depends upon the size of the smallest conductor it protects, and not upon the amount of current to be used on the circuit. Below is a table showing the safe carrying capacity of conductors of different sizes in Birmingham, Brown & Sharpe and Edison gauges, which must be followed in the placing of interior conductors.

Brown & Sharpe.		Birmingham.		Edison Standard.	
Gauge No.	Amp.	Gauge No.	Amp.	Gauge No.	Amp.
0000	175	0000	175	200	175
000	145	000	150	180	160
00	120	00	130	140	135
0	100	0	110	110	110
1	95	1	95	90	95
2	70	2	85	80	85
3	60	3	75	65	75
4	50	4	65	55	65
5	45	5	60	50	60
6	35	6	50	40	50
7	30	7	45	30	40
8	25	8	35	25	35
10	20	10	30	20	30
12	15	12	20	12	20
14	10	14	15	8	15
16	5	16	10	5	10
		18	5	3	5

Switches must:

1. Be mounted on moisture-proof and incombustible bases, such as slate or porcelain.
2. Be double pole when the circuits which they control are connected to fixtures attached to gas pipes, and when six amperes or more are to pass through them.
3. Have a firm and secure contact, must make and break readily, and not stick when motion has once been imparted by the handle.
4. Have carrying capacity sufficient to prevent heating above the surrounding atmosphere.
5. Be placed in dry, accessible places, and be grouped as far as possible, being mounted, when practicable, upon slate or equally indestructible back-boards.

Motors.—In wiring for motive power, the same precautions must be taken as with the current of the same volume and potential for lighting. The motor and resistance box must be protected by a double pole cut-out and controlled by a double pole switch.

Arc lights on low potential circuits must be:

1. Supplied by branch conductors not smaller than No. 12 B. & S. gauge.
2. Connected with main conductors only through double pole cut-outs.
3. Only furnished with such resistances or regulators as are enclosed in non-combustible material, such resistances being treated as sources of heat.
4. Supplied with globes protected as in the case of arc lights on high potential circuits.

FIXTURE WORK.

1. In all cases where conductors are concealed within, or attached to fixtures, the latter must be insulated from the gas pipe system of the building.
2. When wired outside the conductors must be so secured as not to be cut or abraded by the pressure of the fastenings or motion of the fixtures.
3. All conductors for fixture work must have a waterproof insulation that is durable and not easily abraded, and must not in any case be smaller than No. 16 B. & S., No. 18 B. W. G., or No. 3 E. S. G.
4. All burrs or fins must be removed before the conductors are drawn into a fixture.
5. The tendency to condensation within the pipes must be guarded against by sealing the upper end of the fixture.
6. No combination fixture in which the conductors are concealed in a space less than one-fourth inch between the inside pipe and the outside casing will be approved.
7. Each fixture must be tested for possible "contacts" between conductors and fixture, and for "short circuits," before the fixture is connected to its supply conductors.
8. The ceiling blocks of fixtures should be made of insulating material.

ELECTRIC GAS LIGHTING.

Where electric gas lighting is to be used on the same fixture with the electric light:

1. No part of the gas piping or fixture shall be in electrical connection with the gas lighting circuit.
2. The wires used with the fixture must have a non-inflammable insulation, or where concealed between the pipe and shell of the fixture, the insulation must be such as is required for fixture wiring for the electric light.
3. The whole installation must test free from "grounds."
4. The two installations must test perfectly free of connection with each other.

PENDANTS AND SOCKETS.

No portion of the lamp socket exposed to contact with outside objects must be allowed to come into electrical contact with either of the conductors.

Cord pendants must be:

1. Made of conductors, each of which is composed of several strands insulated from the other conductor by a mechanical separator of carbonizable material, and both surrounded in damp places with a moisture-proof and a non-inflammable layer.
2. Protected by insulating bushings where the cord enters the socket.
3. So suspended that the entire weight of the socket and lamp will be borne by knots, above the point where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws. All sockets used for wire or cord pendants should have openings at least equal to one-quarter inch gas-pipe size.
4. Allowed to sustain nothing heavier than a four-light cluster, and in such a case special provision should be made by an extra heavy cord or wire, as a mechanical reinforcement.
5. Equipped with keyless sockets as far as practicable, controlled by wall switches. In no case may a lamp giving more than 50 candle-power be placed in a key socket on a flexible pendant.

CLASS D.—ALTERNATING SYSTEMS.

CONVERTERS OR TRANSFORMERS.

Converters must not:

1. Be placed inside of any building, except the central station, unless as hereinafter provided.
2. Be placed in any but metallic or non-combustible cases.
3. Be attached to the outside walls of buildings, unless separated therefrom by substantial insulating supports.
4. Be placed in any other than a dry and convenient location (which can be secured from opening into the interior of the building, such as a vault) when an underground service is used.
5. Be placed without safety fuses at the junction between main and service conductors and safety fuses in the secondary circuits where they will not be affected by the heat of the converter.

PRIMARY CONDUCTORS.

In those cases where it may not be possible to exclude the transformers and primary wires entirely from the building, the following precautions must be strictly observed:

1. The transformer must be located at a point as near as possible to that at which the primary wires enter the building.
2. Between these points the conductors must be heavily insulated with a coating of moisture-proof material, and, in addition, must be so covered and protected that mechanical injury to them or contact with them shall be practically impossible.
3. The primary conductors, if within a building, must be furnished with a double pole switch, and also with an automatic double pole cut-out where the wires enter the building, or where they leave the main line, on the pole or in the conduit. These switches should, if possible, be enclosed in secure and fireproof boxes outside the building.
4. The primary conductors, when inside a building, must be kept apart at least 10 inches, and at the same distance from all other conducting bodies.

SECONDARY CONDUCTORS.

The conductors from the secondary coil of the transformer to the lamps or other translating devices must be installed according to the rules for "inside wiring" for "low potential systems."

CLASS E.—ELECTRIC RAILWAYS.

POWER STATIONS.

All rules pertaining to arc light wires and stations shall apply (so far as practicable) to street railway power stations and their conductors.

RAILWAY SYSTEMS WITH GROUND RETURN.

Electric railway systems in which the motor cars are driven by a current from a single wire, with ground or floor return circuit, are prohibited *except* as hereinafter provided.

1. When there is no liability of other conductors coming in contact with the trolley wire.
2. When the location of the generator is such that the ground circuit will not create a fire hazard to the property.
3. When an approved automatic circuit breaker or other device that will immediately cut off the current in case the trolley wires become grounded, is introduced in each circuit as it leaves the power station. This device must be mounted on a fire-proof base and be in full view of the attendant.

TROLLEY WIRES.

Trolley wires must be:

1. No smaller than No. 0 B. & S. copper or No. 4 B. & S. silicon bronze, and must readily stand the strain put upon them when in use.
2. Well insulated from their supports, and in case of the side or double pole construction, the supports shall also be insulated from the poles immediately outside the trolley wire.
3. Capable of being disconnected at the power house, or of being divided into sections, so that in case of fire on the railway route, the current may be shut off from the particular section and not interfere with the work of the firemen in extinguishing the flames. This rule also applies to feeders.
4. Safely protected against contact with all other conductors.

CAR WIRING.

All wires in cars must be run out of reach of the passengers, and shall be insulated with a water-proof insulation.

LIGHTING AND RAILWAY POWER WIRES.

Lighting and power wires must not be permitted in the same circuit with trolley wires with a ground return, except in street railway cars, car houses and power stations. The same dynamo may be used for both purposes, provided the connection from the dynamo for each circuit shall be a double pole switch so arranged that only one of the circuits can be in use at the same time.

CLASS F.—BATTERIES.

When current for light and power is taken from primary or secondary batteries, the same general regulations must be observed as apply to such wires fed from dynamo generators developing the same difference of potential.

CLASS G.—MISCELLANEOUS.

1. The wiring in any building must test free from "grounds" before the current is turned on. This test may be made with a magnet that will ring through a resistance of 20,000 ohms, where currents of less than 250 volts are used.
2. No ground wires for lightning arresters may be attached to gas-pipes within the building.
3. All conductors connecting with telephone, district messenger, burglar alarm, watch clock, electric time and other similar instruments must, if in any portion of their length they are liable to become crossed with circuits carrying currents for light or power, be provided near the point of entrance to the building with some protective device which will operate to shunt the instruments in case of a dangerous rise of potential, and will open the circuit and arrest an abnormal current flow. Any conductor normally forming an innocuous circuit may become a source of fire hazard if crossed with another conductor through which it may become charged with a relatively high pressure.

A. J. DECAMP, *Chairman*,
M. D. LAW,
STEPHEN E. BARTON,
WM. BROPHY,
T. CARPENTER SMITH.

Certain questions have come before the committee, which they considered of too great importance to be decided at this stage. Among these are the subjects of the grounding of the neutral wire in compensating or three-wire systems—the grounding, either permanently or by automatic cut-outs, of the secondary wires in transformer systems—the adoption of a uniform alloy for fusible cut-outs, and the adoption of better methods for testing circuits.

From the nature of the electrical business and the rapid advance it is making, there must, of necessity, questions continually arise which can only be decided by a later and larger experience, therefore, the object of the Association would be best served by the appointment of a permanent committee to whom should be referred all such questions, which they shall consider and report upon at the next succeeding meeting of the Association.

Your committee, therefore, offer the following:

Resolved, That a committee of five be appointed by the president, to be a permanent committee on safe methods of construction and operation—any vacancies that may occur on the committee from time to time to be filled by the president.

(Committee.) WM. MCDEVITT,
T. CARPENTER SMITH,
WM. BROPHY,
M. D. LAW.

Mr. C. J. Field then read his paper on electric railway construction and operation. (See Supplement.)

Mr. Burleigh: The paper is an exceedingly interesting one to me. I would like to ask what service is rendered by the local lighting company for the three cents per car mile.

Mr. Field: The actual service is to operate the generators which the street railway companies should install. I believe that the street railway companies should install their own generators, because I believe that questions will arise about accidents happening to their own generators, and the station should only be responsible for ordinary wear and tear—not accidents due to short circuiting, lightning or other causes. That, I think, is the most satisfactory basis for this kind of business.

Mr. Burleigh: The loss of an armature in that case would be borne by the street railway companies.

Mr. Field: Yes, sir.

Mr. Burleigh: Then this three cents per mile is for current?

Mr. Field: For furnishing the steam and the labor. There are some cases where the current has been contracted for for four or five cents temporarily. In Boston, where the West End Company, owing to delays in building their car houses, have had to contract with companies that could not afford to furnish it any less than four or five cents per car mile.

Mr. Burleigh: I would like to ask Mr. Field if he advises central station men to attempt the care of overhead lines, the electrical part of the car equipment, etc.?

Mr. Field: In general, I would say no. I think that is the street railway companies' own business. Any street railway company that is running on a proper basis should have an emergency gang to take care of their own line. Otherwise questions are going to arise. I do not believe in a central station manager attempting any more than he has got under his direct care now, and that is the running and furnishing of power from his station.

The Chairman (Vice-President Ayer): We enjoyed that paper very much. It has proved very interesting and I regret that it was so late when it came up. I think the lesson taught by this sort of experience will result in our taking more time on our programme for the transaction of business which we are here for rather than for outside entertainments. We are compelled now to pass over Mr. Field's paper at a time when we would all be benefited by the liberal discussion which I know would take place. But our programme is fixed, gentlemen, and the next thing to do is to come as near carrying it out as we can. I have a memorandum from Mr. Huntley which says that the Governor-General, who arrived this morning, will receive at 4 o'clock at the residence of Sir Donald Smith.

The convention then adjourned until September 11, at 10 A. M.

Fifth Session—Friday, Sept. 11, 1891.

The Association met at 10 A. M.

The President: We will first take up the paper of Mr. Ayer, entitled "Some Details of the Care and Management of an Arc Light System as Practiced in the 'Municipal,' of St. Louis."

Mr. Ayer: In order to expedite our business, I will omit reading the paper. (See Supplement.) The title of it indicates its character. As you all have copies of the paper, I think it can be discussed without

going through it. I have not made a synopsis of it, or any headings of subjects, but yet, perhaps, I might make some suggestions in connection with it as I have something to say that perhaps can be brought out better in this way than by waiting until we get into the discussion. One point I touch on in the beginning, where I say that I think that our meetings should be largely "experience meetings." In referring to our station, and in giving you this paper, I have done so with the idea of bringing out, developing and inviting other papers of this nature. I want to say, with reference to this station of ours, that the problem which I had there was different from that of almost any central station that I know of to-day. It was to start in and build a plant of large capacity, to spend money far in excess of the requirements of the station by the business in sight, and to build a station which still had a very large business to start with. We already had a contract with the city of St. Louis for 2,000 lights, and the prospect was when the station was first laid out that it would ultimately absorb other companies, take in a number of smaller stations, as was afterwards done; and so my instructions were to build a large station on a given piece of ground, which they handed over to me, as I could, and regardless of what it cost. I was confronted by a problem in that particular which will explain some of the peculiarities of construction which we adopted. I built a station with a working capacity for 6,000 lights, but when the station was put into operation it commenced with 2,000 lamps. All the stations throughout the country, which are in the hands of our members, have, as a rule, grown up from small affairs. They started up in some junk shop or other, with a few dynamos, and grew as the necessities required, and the result is that there has been an enormous amount of patchwork all the way through. But in our station there is nothing of the kind. We had to start off and build something which would be complete in itself, and which was comprehensive enough to take all the work in the near future that was likely to be drawn into it. Since putting the station in operation we have absorbed the other companies, and brought up the output of the station to the number of lights mentioned in the paper. At the time of building this station there was nothing of its character, size or magnitude in this country. The problem which confronted me, aside from the designing and construction of the station, was the system of management to be adopted, the methods to be applied, the details relative to the management of the men—and it all had to be worked out and put in motion with the wheels at the beginning. The plan that I outlined, the blanks that I made for the government of my men, are the ones that I am using today. I have made but few minor changes in the original blanks that were laid out before we had done any work at all in the way of operating. And while, undoubtedly, we have followed in detail many of the practices that have obtained in other central stations in the management of our men and in the division of the work, I want to say that I was unable on applying to a number of cities to get anything to assist me in arranging our blanks or system. It was a thing that could not be found. I have since found, in conversation with central station men who have large plants, that we have thought out the same ways independently—of managing our stations independently—that we are working on similar lines. In some instances it is peculiar that it is so. One object of the paper in outlining the details of practice at our station is because of the fact that it has not been done very much, and because I realized what difficulty I had in endeavoring to obtain information. In fact, I did not obtain any that was of value to us. That is my excuse in a measure for going into details of our plan of working to such an extent in this paper. First I will refer to our method of caring for the street lamps. We have got a number of street lamps distributed over a very large area. The city required that our lamps should be supported very high above the street. The minimum altitude of the lamps is 35 feet above the roadway. The city also required that we should suspend them between the poles. They were arbitrary in the matter. In order to get our lamps at that elevation, the shortest pole that we could use was 50 feet in length. In suburban lighting they require the lamps to be 50 feet above the roadway, and they have to be suspended from 65 to 70 feet poles, according to the length of the span. The average distance apart is about 900 feet. I think that we have about 1,500 lamps where the average distance apart is 825 feet. The balance of them, 500 or more, have an average distance of 1,300 feet between the lamps. These are long distances. In lighting the suburbs, and, in fact, the whole city, we have found the use of a cart and horse very desirable. When one stops and thinks about the work, where lamps are located close together, of easy access, supported by methods which enable the trimmer to get quickly at the lamp, or even supported as mine are, when they are placed so high above the streets, that looks but a small number, because we have, as doubtless many others have, some trimmers who care for more than 100 commercial lamps per day. But we have got our lamps at this high altitude, and it takes a long time to raise and lower them. We are compelled to use a device for raising and lowering, a device which has to be lowered and locked in order to prevent its being meddled with, and that necessitates each time the unlocking of the device by the trimmer, applying the crank, lowering and raising the lamp, and as the poles are set on the curb line of the streets, and passing vehicles could knock the device off easily, the hoisting device has to be placed up high out of the reach of the sides of wagons, and that necessitated the use of a ladder by the men to get up to the hoisting device. It seemed to me before we went into operation that it would be essential that we should have something of that sort. We have a cart modified to suit the requirements, and enabling our trimmers to carry extra globes, extra lamps, rubber clothing, means for keeping the carbons dry, and any number of tools that they wish (and we require them always to carry a few), and to carry the means to enable the trimmer to make any temporary repairs for the purpose of removing any defect or trouble which he may find. We have found that by furnishing our men with cart and horse (requiring them to furnish the horses) we have been able to employ men for $65 per month, who are in every way equal to the men whom we employ for trimming commercial lamps, where they carry a step ladder around the town, at two dollars per day. For $65 per month we find them seeking the positions as trimmers. They furnish their own horses, feeding, shoeing and caring for them in every particular—leaving us only to supply them with vehicles and harness. The cost of maintenance for vehicles and harness is not very great. The cost of outfit was about $75 per trimmer. The cost of repairs and depreciation of harness and vehicles is about 40 per cent. annually, as we calculate it. That is, it will cost about 40 per cent. of the investment to keep it up. That thing has been discussed somewhat and in some other places they have tried the use of carts, and are not altogether pleased with them, but where the conditions are satisfactory, I must say that we find much better results in the care of our lamps in that way than we have ever experienced with the same class of help. With $40 trimmers, such as we have, I doubt if we could get the results that we do in any other manner. We have got a very useful little blank which, I presume, may be advantageously used in many other places. We have printed on it a form of telegraph pole, with 15 cross-arms on it and 10 pins. Although we use no more than eight pins for our work, yet we use other pole lines in carrying our wires over the city, and we keep a record of every pole and wire on those blanks. The location of the pole and the positions of the wires on the pole is indicated on the blank. From the corner of First to Tenth streets, circuit No. 5 will occupy the two outside pins on the top cross bar, and the side of the street and the name of the street is given, so that by reference to that diagram at any time we know the exact location of our own and of other people's wires. In laying out new circuits and in doing addition work it is a very convenient thing to refer to and it saves lots of work. It is very convenient where you have many poles, and especially where you have to run a mixed line and interchange with other companies, to have some such arrangement. In the care of a station, it is rarely the practice in the smaller stations to have anything in the way of instruments, except those furnished by the parent company, and possibly sometimes one outside instrument. We all know the utter unreliability of the ordinary commercial device furnished to us as an ammeter by these parent companies; and unless you do accurately know the amount of current, leaks will creep into the plant, which, I assure you, would astonish any one if they were to go at the matter carefully and measure them. I do not think that there is a station in a town of 20,000 inhabitants and over that can afford not to be provided with a high reading voltmeter (I am now speaking exclusively of and referring only to arc light circuits) that will measure the whole distance of potential on your circuits during the operation of them, so that you may know the amount of energy being consumed, and accurate ammeters are essential in order to know what that energy is. In the paper I have made a point of that. I will give you a statement of a little test. Until I had made the test and made the comparison I could not realize that the difference, or the opportunity for difference, was so great. With ten lamps adjusted to burn an average of 46 volts, with 9.5 amperes of current, the average number of watts of the ten lamps was 436 per lamp. Now, without changing the adjustment of the lamps in any manner, but simply increasing the current so that the ammeter needle read 9.8 amperes (an increase of 0.3 amperes and you will find that the indicator furnished by our parent companies will not agree within half an ampere), with an increase of current of only 0.3 of an ampere the average consumption or increase of watts was 524, or an increase of 20 per cent. in the watts consumed. That was the result of changing only 0.3 of an ampere. When the current was increased so as to give the lamps 10 amperes we had an average voltage of 58 volts per lamp, instead of 46—an average of 550 watts per lamp, or an increase of 33 per cent. in the energy consumed. There is a saving equivalent to a very handsome profit on your lamps. We all know that of ten in a moderate sized station some one will come in and think the lamps are not in good order, and ask, "What is the matter with the lamps? Push them up." The ammeter is found to be all right, but still we give them more energy. Many of our superintendents want to have good lamps, and they want to make a good show with them, and so they keep their lamps bright in this manner. Now, they will get just as satisfactory a light, and a more even light, by having the lamps properly adjusted and running them on a normal current, than they can possibly get in this manner, and be able to save from 33 to 50 per cent. of the energy consumed in those lamps. This is a point that I know a good many of you have already looked into, and you have discovered in practice that it is an opportunity for very serious leaks, but I have never heard any one bring it out before. The matter has never, to my knowledge, yet been before the convention or publicly commented upon. This shows you the necessity of having a good and accurate instrument adapted to your work. Our practice is to take the commercial instruments furnished by the company whose apparatus we use and then standardize them, regardless of their scale, indicating where the needle should stand to indicate the currents that our lamps are adjusted for. We use two Weston ammeters as standard instruments. I find it desirable to have two rather than one. Those we use almost entirely for standardizing these other instruments which we use in practice. There is something very peculiar about an ammeter. I find that they will run along perfectly accurate, and that two or three instruments will agree exactly for a week or 10 days, and then, without any apparent cause, and when working under identically the same conditions and collected together in series, so as to take the same amount of current, the needle will vary sometimes as much as 0.2 or 0.3 on one instrument. Then we bring in our standard instrument and put it in the series in order to find out which one of those has changed its adjustment. It is something that we do not attempt to account for, grouped as they are, for this occurs in cases where we have them fastened to a board against a post, and where all the influences surrounding them are the same under all conditions and at all times, and they are not in close proximity to any wires carrying heavy currents, and there is no opportunity that I know of for change either in condition or position. And yet the change does occur. I think that money expended for good instruments to be used in adjusting lamps and in maintaining the current constant is money well expended. In operating the large number of lamps that we do, if we had an ammeter on every circuit (as some do), we would have a very variable condition of affairs. Of course, these variations in ammeters would exist. We keep continually two ammeters in series. We have a very convenient plug and socket made for inserting the ammeter quickly in the circuit, so as to get it right in circuit. It is placed on the switchboard by simply inserting a single plug. Thus we connect the ammeter in series with the circuit. Our practice is in starting up, as soon as the dynamo is in operation, to insert the plug, and see that the current is what we desire to show by this instrument. We go through the whole series in that way, and that thing is repeated in our station every two hours during the night, and during the day-time once an hour. We find it desirable to do this. While we have not much change in load we have changes in circuit conditions during the night, and the governors are not always responsive to a moderate change of load. You can easily build up your current 0.1, 0.2, or 0.3 of an ampere, and the governor will not always respond. We burn more carbon and, of course, more coal during that time. This matter of circuit connection is often a fruitful source of trouble, as well as one of the causes of an immense loss of energy, and is a thing that we all ought to pay close attention to. I know that all central station men now make it a practice to make a solid circuit by making good line joints, but when we let out a lamp we are very apt to have a binding post there, and we are apt to insert the wire in, either in the hanger-board or on the lamp proper, and the man sets up the set screw and leaves the lamp hanging there, and then the wire will corrode and a condition will be brought about which will soon so disarrange things that a 40 light dynamo will run only 30 lights. We use hanger-boards for suspending all our lamps, whether inside in commercial use or outside in city use. The hanger-boards are all provided with cut-offs. But before the boards were put in service—not before they were put in service, for we put our plant in operation very hurriedly, and so we took our boards as they came from the manufacturer—but, shortly subsequent to that, we soldered a short section of flexible insulated cable to the binding post of each hanger-board, and then when the man comes along to make a line connection after the hanger-board is put in place, he makes an ordinary line joint. Thus they get a good, solid, strong connection. The soldering that is done is done in our repair shop or done at the station, where they have time to have it done well. I have mentioned in the paper that it is our practice to charge the customer for arc light installations. I am aware that this practice does not generally obtain throughout the country. One of my employés, who came to me from an older company, once told me that I was wrong in attempting this; that the thing could not be carried out; that it would make trouble and give us bother in endeavoring to collect from or compel customers to pay for arc light installations. I maintain that there is no more reason why we should do wiring free than there would be for a gas man to charge nothing for piping a house. There is no more reason why a gas man should pipe a customer's house than there is for our wiring a house free for incandescent lamps. Of course, in the early day, when arc lights were still an experiment, we were anxious to get the thing in a man's house so that he would try it, hoping that if he liked it he would keep it, and so we did not charge for wiring. And later on the same thing prevailed, and to get a customer started we were willing to do the wiring for the sake of getting him converted from the present method of lighting by gas to the new method by electricity. And so that practice has been followed up, because the precedent had been established. But there is no sense in it; no matter how much you think, you cannot get away from it. Many of our customers require many short service lamps, as from October to January 1, or perhaps through the winter, taking them out in the spring, and we have customers who take lamps for six months in the year only, their business being of such a nature that they do not require them longer. Those people want the lamps every year, but not for all the year, but still they do not want their wires taken out, and so, to save increased expense to them, and to avoid the taking out and putting in of wires, we require them to sign a contract when the period of service expires for the succeeding session. Then we leave the wires in and agree to connect them without cost. But for our own protection we disconnect them entirely from the circuit. We always cut the wires out of the building, close the circuit at the pole, and take down the loop leading to it. I am satisfied that it is well worth the cost to do this, for then we are in no danger of burning them up, and by cutting them off, closing up and making a solid circuit, we do not have to look for trouble from cut-out boxes, or other bad contacts, nor do we have trouble. The place where men never think to look for trouble is in these dead wires. They forget them. While this costs a little money, I think it saves a little in the end.

Mr. Nicholls: I am not at the present time interested in arc lighting, but when we commenced incandescent lighting we were advised to do free wiring. I took the ground that it would be unbusinesslike—that it would be on the principle of those people who sell tea at so much a pound and give a chromo with it. I thought that we would not develop as rapidly if we did that, as we have fortunately done. We have done our wiring, for the reason that in our city we have not had the advantage of first-class construction companies upon whose work we could depend. There was some little wiring done and it was unsatisfactory, and we started in to do it ourselves as a measure of self-protection. We have connected up—I do not remember the total number—but in the last fifteen months we have wired for upwards of 12,000 lights and we have endeavored to make it as near cost as possible, so as not to make it burdensome to the consumer. Still I find that we have made a very fair percentage of profit, which has gone to defray the many items of expense that would otherwise be chargeable to general expense account. I think, if there could be some understanding that free wiring should not be done, it would help the electrical industries, because when we started to charge we were met with the statement that this town and that town were doing free wiring and we ought to do it the same way. It is simply a matter of business. If we do not charge for wiring we are going to get it out of them in some other way. If we are going to lose 10, 15, 20 thousand dollars a

year for wire we have got to make it up in our meter charges in some other way.

Mr. Francisco: There is one feature of this business that has been overlooked. It is very convenient to carry out Mr. Nicholls' plan, and I fully concur in his views—provided there is only one company in the place. But if you have got two or three different companies an entirely different plan of operations is inaugurated at once. If you charge for wiring, the other company, nine times out of ten, will put the charge for wiring at less, or the people will go to one company and get their price, and then to another company and get their price, and so on, and the man who does it for the least money gets the job every time. Of course, the true way is to charge for wiring, but with competition and two companies I have found it is utterly impossible to charge for wiring, because the other companies would do it for nothing, and, of course, you cannot get parties to take your lights when they can get the same thing without paying for it. In regard to Mr. Ayer's paper, I have been very much interested in his remarks. They have been very instructive to me, because I have had the pleasure of examining Mr. Ayer's station all through. The Good Book says you should not envy, but it seemed to me I could not help feeling very peculiar in going through that station. It is complete in every respect, and there are a great many things there that are instructive, and every electric light man should have the chance to examine, if he could, and adopt them, because they are practical and based on practical working. Now, I hope that we can in time adopt some plan or some arrangement in regard to this very question of free wiring, because it is a very serious difficulty; there is no question about that. In many stations renewals are furnished free. I furnished them myself. I made nothing for renewals on lamps. Of course, it is a dead loss to the company and the charge should be made for renewals the same as is made for wiring and those things, and I trust that in time we may be able to get some basis or plan of operation whereby we can carry this out and have our return for that service, just the same as we do for all other service.

Mr. Nicholls: I am glad Mr. Francisco referred to the question of competition. I think it is better to sell your product at a lower price—to give a discount rather than to give something for nothing. You then know exactly what you are doing and exactly what you can afford to do. If you do free wiring I maintain that you have no right to charge it up to capital account. You ought to charge it to expense account. When once you wire a customer's premises he has you at his mercy. He can tell you to take your wires out. Whereas, if you meet competition by saying we will give you 10, 15 or 20 per cent. discount, then if you have a row with your customer you simply lose his custom, but you are at no financial loss in the matter as regards the actual expenditure of capital, and I think that is a far more reasonable way of meeting competition—to sell the product at a lower price.

Mr. Francisco: I would say that I always charge free wiring to expense and not to construction or anything else. It is a dead loss.

Mr. Seely: Three of the largest companies in New York city started in to do free wiring. I think they spent half a million dollars before they realized the fact that it was an expensive luxury. It cost them on an average about three dollars a light to put in. They finally reached a combination whereby they agreed to charge the customer actual cost. Some enterprising gentlemen put the actual cost down to a dollar and a half a light. His opponent kept his price stiff at three dollars. The three dollar man did not get the business. Finally the wiring got down again to about one dollar a light. But I do not agree with the gentleman about the account to which wiring should be charged. In some large buildings there is $10,000 worth of wire alone. If you make a contract with a man to wire a building you make a contract with him to either buy that wire at the expiration of your contract or to remove it. You will find that companies have spent thousands of dollars in wiring large buildings, and it would be nonsense to charge that to expense. I would like to ask Mr. Ayer a point in relation to the adjustment of the arc lamp. It appears that Mr. Ayer adjusts the ammeter up to the arc lamp. In other words, he establishes a zero point and adjusts his lamp to that zero point. It may be five, 10 or 15 amperes. It may be one ampere. I do not believe that an arc lamp can be accurately adjusted, taking a large plant such as Mr. Ayer has. It is a pretty hard matter to get all those lamps nicely adjusted so that it takes a certain amount of current. We have found in calibrating our meters—we have sent them to an institution of technology and calibrated them there, and sent another to a first-class instrument maker and we would find they would vary. We would write to those gentlemen and they would say they had gone through the work carefully; probably, in shipping, it got out of adjustment. What electric light people at the present time suffer for is accurate instruments—something that will not get out of order.

Mr. Ayer: I would like to say to Mr. Seely, about the inability to accurately adjust arc lamps in a large station, that I think we are more able to do it in a large station than in a small one. I have two young men I give that work to and they have become very expert at it. It is very remarkable how quickly they will detect a flaw in a lamp and locate the cause of it, and the same way about the carbons. It requires practice. In a large station we are better able to do that than it can be done anywhere else. But there is no question that you can get a better adjustment of a lamp by having a constant current maintained on the circuit and arriving at what the average length of arc shall be by the use of a voltmeter rather than by judging it by your eye. If the lamp is in proper condition you will find that it has normal voltage. There is a range between the hissing and the flaming point which, when adjusted by a voltmeter, will bring the lamp where it belongs. But you will frequently adjust a lamp by your eye or judge it by the flaming and hissing point and find that it is either too low or too high. You will find that when you have a lamp that is working defectively from some mechanical trouble—without the instrument you do not detect that. You do not know what the length of arc is, what the voltage consume l is. It is the result of my experience in the matter. We have it under the best conditions where we handle a number of lamps a day—15 or 20 l mps going through our repair shops, being repaired and overhauled—that number of lamps passing through the hands of my own men every day, they have become, as I say, very expert, and they are accurate in arriving at results. By contrast, however, you might mention a manufacturing company. I know that when my lamps were sent to me the parent company stated that they were in good adjustment to hang up on the circuit. Unfortunately —or fortunately, rather—I had been connected with a parent company prior to building that station, and as the lamps came in, I had them taken out and cleaned up and then re-assembled and tested to see where the faults were, and adjusted. I found about 10 per cent. of them that would not burn at all if they had been hung up, and three and a half per cent. that would have opened the circuit, yet it was not apparent in the lamp. But the young men whom they have had put them through a series of tests. Those lamps had all been, as they thought, adjusted. They went along and looked at them. The men who did that were earning a dollar or a dollar and a half a day. They never saw the lamps afterwards, and knew very little of them, anyway. Now, taking their experience of it, one would say that their method of adjusting would not amount to very much, and the adjustment of arc lamps was not a very practical thing. But my experience is that it is a very practical thing, and can be arrived at very closely, but it takes time, and you must take one or two of your station men and insist on their doing it. The way I have insisted on it is to have the lamp burn eight hours, compel them to go through that whole thing during the whole period of the consumption of the carbon. It costs a little money, but the money is saved in the end. It does not cost half as much to burn a lamp all day and supply it with carbons, as to put that lamp into service and have the defects develop after it has been hung up. Take a double carbon lamp, it will burn all right. Try it on the other side, it will burn all right. In an hour it will go out. By this method of testing, you will discover the cause of that. I use boys in this work, 18 or 19 years old. They are paid $35 or $40 a month for that character of work. I keep sifting them through. Ultimately I think I am going to have some bright boys. It is just like making rules and having systems. If you make a rule you want to enforce it. They used to think lamp adjustment was fun, but I insisted on their working around, applying the voltmeter and the ammeter. That is a point on which I think there is no danger of laying too much stress. I have a most satisfactory governor. It gives me no trouble. You have to put an accurate, delicately adjusted ammeter on any dynamo. I know of no governor that will hold its place in all conditions. If you would indicate such a one to me (to Mr. Orford) I would like to have you do so.

Mr. Orford: I will not indicate it. But they must be made; there is no reason why they cannot be made. I have been operating arc lamps for seven or eight years, and I have had various types of arc machines, and I know there are some of them, as Mr. Smith said the other day, on which the only governor is a big load. I think it is a very crude way of running a station to trust to the machine without a governor. It is really going to the same practice as taking the governor out of the engine. Nobody would dream of setting up a locomotive or stationary engine without setting up a good governor, and in a great many instances the highest price will be obtained for an engine having a good regulating governor, and the same thing can undoubtedly be done with the arc machine. I suppose the fact that people do not look out for the best governor is evidence that they are satisfied with what they have. I am not saying this for the purpose of advertising any person's dynamo. I have been accused of doing that at times. But it is because I am somewhat peculiar on that point. I know there are dynamos in existence to-day, and if you take one light it will show it is running 10 amperes. Take the Weston. You put 40 lights on that machine, it will show 10 amperes. I know the regulating devices have to be carefully looked to, but when once placed in position they give no trouble. That is my experience in seven years. The same thing can be said of an arc lamp. An arc lamp to my mind requires only one adjustment. I have arc lamps in operation in stores for six years and they have never been touched. The only thing they have had done to them has been the trimming. You bring those lamps into the station, and if those lamps do not burn as well as the average lamp I will take a back seat. I think I can say that I have had the credit—without being egotistical—of having as good lamps as can be shown anywhere. I certainly know that an arc lamp can be constructed, and having once adjusted it for whatever current you intend maintaining, your arc lamp will burn correctly if you maintain that current. With reference to this opposition, which is constantly cropping up, when we started into the incandescent business we thought the wisest thing would be to go to the customers, get as good a price as we could, and ask them for as small an amount to begin with as possible. Their gas fixturers were all in the stores. We had to say something to them to get them to adopt the electric light in preference to gas and we thought it would not be a very good method to begin by telling them that they had to pay for the wire. Consequently we took the ground that the smaller the expense to the customers in the first instance the more customers we would be likely to get. We recognized the fact that we were going to spend a considerable amount of money in wiring stores and we thought it would be a permanent business. We have had the incandescent light in stores for four years. We have had very good prices. The cost of installation is a small amount when you spread it over four or, perhaps, 40 years. I see no deterioration of the material, and the amount of money necessary to keep it in good condition is very small indeed. The question of renewals is one about which we have debated very considerably. The only advantage which I see in the customer buying his lamps would be that we could sell them in a bunch and have done with it, whereas we supply them one or two at a time, as required. The disadvantage of the customer buying his lamps has appeared to us to be that some of them might burn the lamps as long as they would burn and in that way it would not be very creditable to us as we have to compete with very good gas. Now, then, if the convention can help us in any way to kill competition in our town we would like to get some assistance. The competition which has been threatened us has been threatened by a member of the Association, and if the Association can do anything to keep a member from coming into competition with another member of the Association, we should be glad of its assistance.

Mr. Scott: I feel very grateful to Mr. Ayer for his talk. It is just the kind of talk I came here to listen to. We do not have arc lights but we have incandescent lights. I gather a vast amount of valuable information from what he says and I understand well the importance which he attaches to standardizing a voltmeter and an ammeter by an instrument not made by the parent company. We have standardized voltmeters and ammeters made by the parent company, but the voltmeters and ammeters on the switchboard are apparently all right according to that, but in testing otherwise I found that one street loop having an amperage of about $7\frac{7}{16}$ running on the series system, showed, when I put it on to one machine by itself, eight amperes by that ammeter, on the other machine 10 amperes by that ammeter, and on another machine 11 amperes by that ammeter. I transferred the ammeter to the other machine, and I found the trouble was in the instrument itself. In testing the exciters of the direct current machine I found one was given 98 volts, another 115, another 140. There is evidently something wrong about that, and I did that only by getting a Weston current voltmeter and put on in the place of the voltmeters which we have in the station. I think it is of a great deal of importance to everybody. Our men are told to test and standardize the voltmeter and ampere meter every hour. In regard to free wiring, we have stopped that.

Mr. Orford: Any one familiar with an arc light station knows that we do not use Thomson's reflecting galvanometer to take readings by. There is no use in using an ammeter which fluctuates backwards and forwards. We use a Weston dead beat. The simplest way that I know of to keep your ammeters and voltmeters in good order is to have a pair of them. If you have a pair of ampere meters and put one in the station for every evening so that you can take a test once a month, that ampere meter will stand you a dozen years. If it is not possible to make an ammeter that will stand such a test as that, our friend Mr. Weston's life is spent in vain, I should say. Every one knows the difficulty of keeping a voltmeter in circuit that is only required on the incandescent work. A voltmeter being in a circuit is quite unnecessary, in my opinion, for incandescent work. If you could get a Howe's lamp regulator you will find that that regulator will answer your purpose. Of course, the action of the voltmeter is principally on the lamp that is burned with it. They supply an excellent lamp, and you recalibrate that lamp once a week, if you desire. My experience has been for four years with them. I assume that the Howell indicator will get out a little, but it is a very small amount. But you can take your lamp, regulate it and calibrate it to suit yourself. You can do it once a night if you like. We find that once a week is quite ample. Of course, our readings are taken from the mains that go up the street. We take our readings from the mains occasionally with one of Weston's voltmeters. With that method we are able to find out whether our station instruments are pretty nearly accurate. I do not wish to be understood as saying for a moment that there is no variation in our current. The governor will not move unless there is a change in the speed. It is the same with the regulation of the arc lamp. Any one familiar with the regulation of the arc machine will know that the current does not stand steady. It goes backward and forward, up and down. You can limit it by devices which they have supplied and keep it moving but a very small amount. The arc lamp is not such a sensitive instrument that it is going to go out because there is a variation of 10 per cent., even in your current. I think you can vary the current 10 per cent. and there is not a man in the room can tell the difference. I can give you an instance. I happen to be running a machine which is really a 65 light machine. It is a Brush machine. I was competing with the Thomson-Houston. I gave them pretty good competition and I dropped the current. I had 75 lights on the machine I dropped my current down and there was not a person who knew anything about it. In fact, a couple of years afterwards one of the lamps which I had had in use happened to get into the hands of one of my former competitors, and he got it on his regular 10 ampere circuit, and he was surprised at the action of the lamp and wondered why that lamp had changed so much since I had it. He was not aware that I was running eight amperes. My competitor was running 10. Consequently, you see that the difference of a quarter of an ampere, even in a lamp, is of no moment.

Mr. Seely: I believe the point made by Mr. Ayer is, that in large stations running an ampere more or less is a question of coal supply only, and not a question of reducing the light. I think that seven-eighths of an ampere makes a difference in profit of $75 in the coal. Those are the points he desired to bring out. A man said to me that he could reduce his amperes to nominally nothing and still give light. I would like to know how you can hold your voltage if you cut down your amperes. I have seen some stations running five amperes for a 2,000 candle-power lamp. If you gentlemen desire to go and see a ten, an eight and a half, or a seven ampere lamp, and say that there is no difference, I would like to have you do it. I have had the pleasure of visiting nearly all the prominent stations throughout the United States in the past two months and I could see a difference in the light.

Mr. Orford: I do not advocate the running down of the current, but I say that a small amount of reduction cannot be perceived in a lamp. Nevertheless, I do not advocate it. But I do say that such machines are in existence, and in every-day operation (and if any one will come to Bridgeport they can see for themselves). We go over our machines every night, take the plug out, put the ammeter in circuit and see if it is all right. Night after night, week after week, and month after month, those machines will run, and run correctly. Of course, the needle will vibrate a little high or low. I certainly would not advocate any attempt to give your customers any more than you are obliged to give, but it is your salvation to give them satisfactory lights; but as to the question of the volume of current passing into the lights, I have been in Montreal, and I declare that I could not tell to-day whether they are burning a 1,000 lamp or a 2,000 lamp. I think that gentlemen will admit, who have made this arc light business a study, that it is a great many times more difficult to tell whether a lamp is operated by a seven, or by a six-eighths, or by a ten ampere current.

The President: If there is no further discussion on this paper, I will call upon Mr.

Nicholls to read the paper of Mr. Warner on "Different Forms of Carbons Used in Arc Lighting."

(For Mr. Warner's paper, see Supplement.)

Mr. Nicholls: Considering the lateness of the hour and the fact that we are to have an executive session which will likely consume considerable time, I would suggest that on this occasion Mr. Warner's paper be taken as read. I think that every member of the Association has received a copy and has read it. It is a short, terse and practical paper; but it is a paper that, so far as I can see, calls for very little discussion. And so, with your permission, I move that Mr. Warner's paper be taken as read.

Mr. Armstrong: I second the motion.

(The motion was agreed to.)

On motion of Mr. Francisco, amended by Judge Armstrong, it was resolved that the rules for safe wiring adopted by the convention be at once printed and a copy sent to each central station and insurance association in the United States.

On motion of Mr. Francisco, Sir William Dawson, Frank R. Redpath and Prof. Henry T. Bovey were elected honorary members of the National Electric Light Association, on the recommendation of the executive committee. On motion of Mr. Seely, and by recommendation of the executive committee, Mr. Thomas D. Lockwood was also elected an honorary member.

The convention then went into executive session.

Executive Session.

The secretary presented the following report:

The condition of the Association, so far as its membership goes, is much stronger and more encouraging than it was at the opening of the year. Many individual memberships have been dropped since the adoption of the present constitution, owing to the fact that memberships are, under it, very largely represented by corporations and firms, instead of individuals. Notwithstanding this fact, a quite large addition has been made since the last report of your secretary, and the general interest in the affairs and work of the Association has very largely increased, owing to the very active agitation concerning the very important benefits arising from a membership and the representative character of the Society.

According to the last secretary's report, the number of members who had paid dues for 1891 was as follows:

Active members, 65: associate members, 107. Total, 172. The present membership stands as follows: Active members, 78; associate members, 142. Total, 220.

I beg to say, in connection with the total membership of this Association, that it is far from what it should be, and far from what it might possibly be made, in view of the immense possibilities for the diffusion of valuable information within its grasp. Our active membership list, especially, should be very largely increased, and could be by making an active membership a valuable consideration and worth more than the annual dues amount to, in the way of practical information furnished during the year. I would suggest that the Committee on Data be increased in its membership, and that the collection and distribution among our members of important facts, figures and details relating to the furnishing of light, heat and power, be carried out systematically, persistently, throughout the year. There is a vast field here for good, and I consider it important a work as the Association has to do. Respectfully submitted.

On motion, the report was received and filed. The treasurer's report was then presented by Mr. Beane, as follows:

This report is made from April 1, dating from the beginning of office, until July 1.

Our fiscal year, dating from January to July and July to January of each year. This report is based on the books of the Association, and on the trial balance of the auditor, on April 17, and on my trial balance of July 1.

The operations of the treasurer, as regards receipts, is indicated by schedule "A," the total receipts being $1,265.00; total disbursements amount to $1,387.62, making the disbursements $123.62 over the receipts for that period. The proof of this is contained in the following: Balance in the bank April 17, indicated by the auditor's trial balance, was $1,371.15; balance in bank July 1, indicated by trial balance, $1,122.02; cash on hand July 1, $128.51; total of cash on hand July 1, $1,250.53; which total is $122.62 less than the amount on hand April 17, proving the difference between the receipts and disbursements, as indicated by the report.

The assets of the Association on July 1 consist of cash in bank, $1,122.02; and the value of furniture account charged with $214.15. The assets were further increased by the payment by the Committee on Exhibits of money disbursed, and their account is schedule "B." Respectfully submitted.

The report was, on motion of Mr. Seely, referred to the Finance Committee.

Dr. Mason, offered the following resolutions, which were unanimously adopted by a rising vote:

The National Electric Light Association, assembled in Montreal, at the close of its session, desires to put upon record its appreciation of the distinguished honor shown it by the Dominion of Canada in the presence of His Excellency, Lord Stanley of Preston, Governor-General of the Dominion.

Of the large hearted hospitality of the City of Montreal, evidenced by many grateful acts, official and individual.

Of the tireless industry of the Citizens' Executive Committee, whose efforts have carried to completion the most successful meeting in the history of this body.

Of the grand work done by the Committee on Exhibits, issuing in an Exhibition of rare educational value, calculated to develop a larger appreciation of the flexibility of electricity and its wide adaptation to human needs.

Of the gracious liberality of McGill College, which has lent the great dignity of its name and the personal influence and labor of its officials to the success of our meeting.

To the press of this city, whose extensive and fair reports of our meetings have extended our influence.

To the railway companies, for their liberal reduction in fares, and to the Windsor Hotel management, where, as guests, we have found a home.

Resolved, That the above minutes be placed on the records of the Association and a certified copy thereof be sent to the various bodies mentioned.

On motion of Mr. Seely, seconded by Judge Armstrong, the following resolution was adopted:

Resolved, That a vote of thanks be tendered Mr. J. I. Gulick for the efficient and successful management of the exhibition now being held under the auspices of this Association, the largest ever held on this continent; and that the Secretary be directed to have this resolution engrossed and presented to Mr. Gulick.

On motion of Mr. Seely, seconded by Dr. Mason, a vote of thanks was extended to Mr. Luther Stieringer.

Mr. Frederic Nicholls, Mr. M. D. Law and Mr. A. M. Young were elected members of the executive committee of the third class.

Dr. Mason gave notice of the following amendment to the constitution: That in the first article the word "International" be substituted for the word "National," so that the title of the Association would be "The International Electric Light Association."

Buffalo was selected as the place for holding the February meeting of the Association.

On motion of Mr. Seely, a vote of thanks was extended to Mr. Allen R. Foote for his services.

The convention then adjourned.

The Visitors to Montreal.

LADIES.

Mrs. Cyrus O. Baker, Jr., Newark, N. J.
Miss Estelle J. Barney, New York.
Mrs. M. J. Francisco, Rutland.
Miss Evelyn Hamell, Philadelphia.
Mrs. E. F. Peck, Brooklyn.
Mrs. John A. Seely, New York.
Mrs. Schuyler S. Wheeler, New York.
Mrs. A. M. Young, Waterbury, Conn.
Mrs. A. F. Mason, Boston.
Mrs. W. H. Moore, Plainfield, N. J.
Mrs. Frederic Nicholls, Toronto, Canada.
Mrs. C. R. Huntley, Buffalo.
Miss Elizabeth W. Armstrong, Camden, N. J.
Mrs. Alexander Chenowith, New York.
Mrs. H. L. Mann, Washington, D. C.
Mrs. J. W. Marsh, Pittsburgh, Pa.
Miss Margaret Middleditch, Brooklyn.
Mrs. J. K. Smith, Johnson City, Tenn.
Mrs. J. D. McIntire, Syracuse, N. Y.
Miss W. A. Lynch, Canton, Ohio.
Mrs. C. Lee Abell, Buffalo.
Mrs. W. J. Morrison, New York.
Miss E. Clark, New York.
Mrs. C. T. Richmond, Fremont, Ohio.
Mrs. F. L. Dallon, Brooklyn.
Mrs. B. F. Hamilton, New York.
Miss Harriet Billings, New York.
Mrs. E. E. Bartlett, New York.
Mrs. W. T. Hunt, New York.
Mrs. W. J. Johnston, New York.
Mrs. C. H. Barney, New York.
Mrs. H. L. Lufkin, New York.
Mrs. Charles W. Price, New York.
Mrs. W. H. Beardsley, New York.
Mrs. George T. Manson, New York.
Mrs. James Pass, Syracuse.
Mrs. F. H. Leonard, Syracuse.
Mrs. J. M. Orford, Bridgeport, Conn.
Miss Emily Smith, Bridgeton, N. J.
Miss Mildred Abell, Buffalo, N. Y.
Mrs. F. E. Barker, Boston.
Mrs. S. B. Chase, Chicago.
Mrs Eugene F. Phillips, Providence.
Mrs. George Hutchinson, New Haven, Conn.
Mrs. F. C. Mason, Brooklyn, N. Y.
Mrs. George Cutter, Chicago.
Miss L. Haywood, New York.
Mrs. A. H. Patterson, New York.
Mrs. W. L. Candee, New York.
Mrs. A. B. McDonald.
Mrs. Benj. R. Western, New York.
Mrs. T. J. Smith, New York.
Mrs. H. M. Swetland, New York.
Mrs. C. E. Bibber, Boston.
Mrs. H. M. Daggett, North Attleboro, Mass.
Mrs. S. G. Stiness, Pawtucket, R. I.
Mrs. H. H. Fairbanks, Worcester, Mass.
Mrs. O. K. Stewart, Boston.
Mrs. W. W. Castle, Boston.
Mrs. M. W. Brown, Boston.
Mrs. F. E. Donahue, Boston.
Miss Donahue, Boston.
Mrs. J. V. Hale, Malden, Mass.
Mrs. G. S. Boutwell, Worcester.

GENTLEMEN—NEW YORK.

Ackerman, P. C., manager N. Y. office American Electrical Works.
Alexander, P. H., Alexander, Barney & Chapin.
Babcock, W. R., Southern Passenger Agent Central Vermont R. R.
Barney, Gen. C. H., manager Electrical Exhibition.
Bartlett, E. E., Bartlett & Co.
Bell, Dr. Louis, *The Electrical World*.
Beane, John W., secretary and treasurer National Electric Light Association.
Beardsley, W. H.
Burdick, J. R., H. W. Johns Co.
Caldwell, Edward, *The Electrical World*.
Candee, Captain Willard L., manager International Okonite Co.
Cavell, E. V., *Street Railway News*.
Coles, Stephen L., associate editor ELECTRICAL REVIEW.
Colvin, F. R., *The Electrical Engineer*.
Chalmers, H. G., Alexander, Barney & Chapin.
Castle, Wm. W., P. & B. Conduit and Construction Co.
Chase, S. A., Western Electric Co.
Chenowith, A. C., Monolithic Conduit Co.
Chenowith, Master.
Crane, W. F. D., Electrical Equipment Co.
Cullen, W. F., E. P. Gleason Manufacturing Co.
Davis, A. E., *Electric Power*.
Davis, C. J., stenographer.
Dillont, Col. J. Frank, *The Electrical World*.
Dunham, S. E.
DeRonde, Frank S., Standard Paint Co.
Dreyfuss, T. G.
Ferguson, C. G., N. Y. City Press Association.
Field, C. J., Field Engineering Co.
Foster, H. A., Special Agent Electrical Census.
Godfrey, J. W., New York Insulated Wire Co.
Greene, S. D., Edison General Electric Co.
Guy, George H., *Electricity*.
Vance, A. S., general superintendent H. Ward Leonard & Co.
Hamilton, B. F., Sawyer-Man Electric Co.
Hammer, W. J., electrical expert.
Hart, L. H., *The Electrical World*.
Harrington, F. W., Tropical American Telephone Co.
Hunter, R. J., Patterson Gottfried & Hunter.
Insull, Samuel, Second Vice-President Edison General Electric Co.
Johnston, W. J., *The Electrical World*.
Johnston, Albert E.
Keefer, E. D., Western Electric Co.
Kelly, J. F., Edison General Electric Co.
LaRue, George W., Crocker-Wheeler Electric Motor Co.
Leonard, H. Ward, president H. Ward Leonard & Co.
Little, E. W., general manager Interior Conduit and Insulation Co.
Lufkin, H. L., manager "C. & C." Electric Motor Co.
Manson, George T., International Okonite Co.
Martin, T. C., *The Electrical Engineer*.
McLaughlin, J. R.
McQuaide, James P., treasurer National Conduit Manufacturing Co.
Mills, H. H., American Electric Light Co.
Muir, John, Edison General Electric Co.
Myerson, E., stenographer.
Noll, Augustus, New York Insulated Wire Co.
Outcalt, R. F., *Electrical World*.
Oscanyon, Paul, electrician Interior Conduit and Insulation Co.
Paine, C. McL., *Electricity*.
Patterson, A. H., Phœnix Glass Co.
Peck, E. H., Phœnix Glass Co.
Pearce, Frederick.
Phelps, G. M., *The Electrical Engineer*.
Pierrez, J. C., Goodrich Hard Rubber Co.
Price, Chas. W., editor ELECTRICAL REVIEW.
Richards, H. T., ELECTRICAL REVIEW.
Roach, M. C., General Eastern Passenger Agent, N. Y. Central & Hudson River R. R.
Ryan, R. W., official stenographer.
Schieren, C. A., Jr., C. A. Schieren & Co.
Seely, John A., manager Complete Electrical Construction Co.
Seller, H. W., mechanical engineer.
Shain, Charles D., Edison General Electric Co.
Shainewald, Ralph L., president Standard Paint Co.
Shippy, H. L., John A. Roebling's Sons Co.
Smith, H.
Smith, H. J., Edison Electric Illuminating Co.
Smith, T. J., the E. S. Greeley & Co.
Steinberger, Joseph, Fibrone Co.
Stieringer, Luther, electrical engineer.
Stump, C. E., *Street Railway Journal*.
Sullivan, M. J., Edison General Electric Co.
Sullivan, M. C.
Swetland, H. M., *Power-Steam*.
Taltavall, T. R., *Electrical Age*.
Taylor, S. F., Patterson, Gottfried & Hunter.
Voorhees, F. Day, general sales agent Norwich Insulated Wire Co.
Van Der Weyde, Dr. P. H.
Walsh, Louis, Thompson & Robertson.
Western, Benj. R., Manufacturers' Advertising Bureau.
Wetmore, Jean A., International Okonite Co.
Wetzler, Joseph, *The Electrical Engineer*.
Wheeler, Schuyler S., Crocker-Wheeler Electric Motor Co.
Wiman, Erastus, president, Richmond Light, Heat & Power Co.
Wiley, G. L., Standard Underground Cable Co.
Wood, E. E., *Electrical Industries*.
Master Franklin A. Johnston, New York.
Master Percy R. Western, New York.
Master Albert H. Smith, New York.

BOSTON, MASS.

Barker, F. E.
Belknap, Chauncey, Thomson-Houston International Electric Co.
Bibber, C. E., Consolidated Electric Manufacturing Co.
Bottomley, H., Germania Electric Co.
Brophy, Capt. Wm., Electric Mutual Insurance Co.
Brown, M. W., Eastern Electrical Supply Co.
Burghardt, G. H., Page Belting Co.
Castle, W. W., Standard Paint Co.
Clark, A. T., American Circular Loom Co.
Craig, J. H., Holtzer-Cabot Electric Co.
Crosby, E. H., *Boston Post*.
Davenport, G. W., Thomson-Houston International Electric Co.
Donohue, F. E., Sawyer-Man Electric Co.
Field, A. B., Supply Department Thomson-Houston Co.
Hamblett, G. H., manager C. H. Schieren & Co.
Hanley, T. H., Central Vermont Railroad.
Kellogg, Chas. P. F.
Lean, G. R., Bernstein Electric Co.
Mason, A. F., general manager Simplex Electric Co.
Price, C. B., Pettingell-Andrews Co.
Shaw, A. C., *The Electrical Engineer*.
Stewart, O. K., Germania Electric Co.
Waterman, John B., Thomson-Houston International Electric Co.
Wilson, J. S., *Electrical Enterprise*.

CHICAGO.

Baker, John S., *Western Electrician*.
Beggs, John I., Edison General Electric Co.
Crandall, C. D., manager Western Electric Co.
Cutter, Geo., Electrical Specialties.
Dean, D. B., Electric Merchandise Co.
Dickerson, J. W., *Electricity*.
Hornsby, J. A., secretary Electrical Department World's Columbian Exposition.
Kreidler, W. A., *Western Electrician*.
Meeker, Geo. H., Western manager N. Y. Insulated Wire Co.
Monroe, P. G., *Stationary Engineer*.
O'Hara, J. B., *Western Electrician*.
Pearson, W. B., Ball and Wood Co.
Smiley, Hugh, Globe Electric Cordage Works.
Taylor, William, The Electrical Supply Co.
Weir, F. W., Falls Rivet and Machine Co.
Wilmerding, C. H., Chicago Arc Light and Power Co.
Wilcox, W. R. B., Electric Merchandise Co.
Winston, H. S., Illinois Electrical Material Co.

ALBANY, N. Y.

Frey, Charles P., chief electrician Greeley Laboratory.

ALLEGHENY, PA.

Hunter, J. D., City Lighting Station.

BATIMORE, MD.

Greenafelder, L. S., Ries Electrical Specialty Co.
Ries, Elias E., Ries Electrical Specialty Co.

BRANTFORD, ONT.

English, E. L., Waterous Engine Works Co.

BRIDGEPORT, CONN.

Bryant, W. C., manager Bryant Electric Co.
Hamilton, C. A., Bridgeport Brass Company.
Orford, J. M., president Union Electric Manufacturing Co.
Stanley, H. D., Bridgeport Brass Company.

BRIDGETON, N. J.

Smith, Fred. F., secretary Ferracute Machine Co.

BRISTOL, PA.

Scott, Chas. E., Bristol Electric Light and Power Co.

BROOKLYN, N. Y.

Dallon, F. L., City of Brooklyn Police Commissioner.
Ferguson, Jas., superintendent Municipal Electric Light Co.
Mason, F. C., Gamewell Fire Alarm Telegraph.
Peck, E. F., general superintendent Citizens' Electric Illuminating Co.

BUFFALO, N. Y.

Abell, C. Lee, manager Thomson-Houston Electric Light Co.
Abell, Master Harold L.
Boulton, W. H., Aluminium Carbon Co.
Huntley, C. R., secretary Buffalo Electric Light and Power Co.
Day, Charles, Jr., Buffalo Electric Light and Power Co.
Ford, A. W., Brooklyn Electric Light Co.
Haviland, J. M., Brooklyn Electric Light Co.
Naughton, J. W., Brooklyn Electric Light Co.
Miller, J. C.

CAMDEN, N. J.

Armstrong, E. A., president Camden Lighting and Heating Co.
Burleigh, J. J. general manager Camden Lighting and Heating Co.

CANTON, OHIO.

Lynch, W. A., general manager Canton Electric Light and Power Co.

CINCINNATI, OHIO.

La Boiteaux, F. M., electrician La Boiteaux Electric Motor and Fan Co.

CLEVELAND, OHIO.

Smith, W. D., National Carbon Co.

CUYAHOGA FALLS, OHIO.

Babcock, E. W., president Falls Rivet and Machine Co.
Long, J. A., vice-president Falls Rivet and Machine Co.

DALLAS, TEX.

Clower, B. M., Clower, Harris & Co.

DANBURY, CONN.

Wightman, E. T., superintendent Danbury Electric and Gas Light Co.

ELIZABETH, N. J.

Ogden, S. R., Elizabeth Electric Light Co.

ELLSWORTH, ME.

Palmer, F. S., Ellsworth Illuminating Co.

FREMONT, OHIO.

Richmond, C. T., president Thomson-Houston Carbon Co.
Urquhart, D. F., Thomson-Houston Carbon Co.

GREAT BARRINGTON, MASS.

Russell, J. L.
Mignery, J. H., Great Barrington Electric Light Co.

HARTFORD, CONN.

Hart, Gerald W., Hart & Hegeman Co.
Hatch, E. B., secretary Johns-Pratt Co.
Tolles, C. L., Jewell Belting Co.

HOUGHTON, MICH.

Dee, James R., general manager Peninsula Electric Light and Power Co.

KANSAS CITY, MO.

Weeks, E. R., manager Kansas City Electric Light Co.

LA FAYETTE, IND.

MacMullan, R. H., manager Brush Electric Light Co.

MALDEN, MASS.

Clark, C. A., B. S. Hale & Co.

MILWAUKEE, WIS.

Coleman, S. G., Badger Electric Co.

MONTREAL, CANADA.

Corbett, M. W., Edison General Electric Co.
Ness, T. W.
Shaw, W. B. S., with T. W. Ness.

NEWARK, N. J.

Baker, C. O., Jr., Baker & Co.
McIntire, C. H., C. McIntire & Co.

NEW BRITAIN, CONN.

Whitney, L. C., New Britain Electric Light Co.

NEW BRUNSWICK, N. J.

Wisner, Frank P., Consolidated Fruit Jar Co.

NEWBURGH, N. Y.

Odell, H. B., Newburgh Electric Light and Power Co.

NEW HAVEN, CONN.

Hutchinson, G. W., Electric Time Co.

NORTH ATTLEBORO, MASS.

Daggett, H. M., treasurer Steam and Electric Co.
Dillon, L. W., president Steam and Electric Co.
Guild, C. T., Steam and Electric Co.

NORTH EAST, PA.

Phillips, J. R., Eureka Tempered Copper Co.
Possons, N. S., Eureka Tempered Copper Co.
Rodman, C. L., manager Globe Carbon Co.

OGDENSBURG, N. Y.

Findlay, J. H., manager Ogdensburg Gas Co.

OTTAWA, CANADA.

Gisborne, F. N., Government Telegraph Service.

PAWTUCKET, R. I.

Stiness, S. G., superintendent Pawtucket Gas and Electric Light Co.

PERU, IND.

Burns, R. C., Peru Glass and Carbon Co.

PHILADELPHIA.

Bournonville, A., Alfred F. Moore.
Braddell, Alfred E., insurance inspector.
McDevitt, William, insurance inspector.
Mainwaring, A. H., Brush Electric Light Co.
Smith, T. Carpenter, manager Keystone Electric Light and Power Co.
Vallee, G. A., Vallee Bros.

PITTSBURGH, PA.

Baxter, G. A., general manager Allegheny County Lighting Co.

Marsh, J. W., general manager Standard Underground Cable Co.
Ridall, J. E., Brush Electric Co.
Young, E. P., Sewickly Electric Co.

PLAINFIELD, N. J.

Moore, W. H., Electric Light and Power Co.

PROVIDENCE, R. I.

Davenport, W.
Phillips, Eugene F., American Electrical Works.
Phillips, E. Rowland, American Electrical Works.
Hathaway, W. A., American Electrical Works.
Whittier, R. H., Drake, Payson & Whittier.

RUTLAND, VT.

Carruthers, Jas., Marble City Electric Light Co.
Francisco, M. J., president Rutland Electric Light Co.
Francisco, Master Don.
Francisco, I. H., secretary Rutland Electric Light Co.

SCHENECTADY, N. Y.

Law, M. D., Edison General Electric Co.

SOMERVILLE, MASS.

Dow, C. T., Somerville Electric Light Co.

ST. LOUIS, MO.

Ayer, Jas. I., general manager Municipal Electric Light and Power Co.
Hazeltine, C. W., president Hazeltine Electric Co.

SYRACUSE, N. Y.

Hawkins, F. M., Electric Engineering and Supply Co.
Hines, Jesse L., Electric Engineering and Supply Co.
Leonard, F. H., Jr., manager Electric Engineering and Supply Co.
Seymour, A. P., Pass & Seymour.

TAUNTON, MASS.

Donnelly, Wm. T.

TORONTO, CANADA.

Barr, M. D., Edison General Electric Co.
Johnson, Phelps, Ball Electric Light Co.
Morrison, W. J., general agent Fort Wayne Electric Co.
Nicholls, Frederick, manager Incandescent Electric Light Co.
Rosentengel, W. R., Edison General Electric Co.

TRENTON, N. J.

Perrine, F. A. C., electrician John A. Roeblings' Sons' Co.

WALTHAM, MASS.

Hill, F. T. G., Waltham Gas and Electric Co.

WASHINGTON, D. C.

Foote, Allen R., agent Census Bureau.
Royce, Fred. W., Royce & Marean.

WATERBURY, CONN.

Mills, A. H., Steele & Johnson.
Young, A. M., secretary Connecticut Electric Co.

WILMINGTON, DEL.

Tyson, F. C., Kartavert Manufacturing Co.
Sweeten, F. D., Delaware Electric and Supply Co.

WINDSOR, CONN.

Baird, M. E., Eddy Electric Co.
Newton, A. D., Eddy Electric Co.

WORCESTER, MASS.

Fairbanks, H. H., Worcester Electric Light Co.

THE ELECTRICAL EXHIBITION AT THE VICTORIA SKATING RINK.

Immediately in the rear of the Windsor Hotel, fronting on Drummond street, is located the large Victoria Skating Rink, where many of the famous Winter carnivals of Montreal are held. This was the place chosen for the electrical exhibition, and by a great deal of hard work on the part of General C. H. Barney and his assistants, the rink, which had no floor when operations began, was prepared for the heavy apparatus, and the interior was handsomely decorated with bunting and the intermingled British and American flags. The exhibits occupied the floor only, the gallery being reserved for visitors.

In point of number of exhibits and its representative completeness as a whole, this exhibition exceeded by far the best previous effort of the National Electric Light Association. General C. H. Barney's services as general manager were invaluable, and the smoothness with which everything worked was due in a large measure to him and his efficient staff. The attendance at the exhibition was much in excess of what had been hoped for. On the opening night there were doubtless 5,000 persons in the rink, and on each succeeding night the attendance closely approached 3,000.

The exhibition was opened with great pomp on Monday evening, September 7. At 8 P. M. the rink was lighted by a number of flickering gas jets, and all the machinery was silent. A distinguished party assembled in the gallery at the front of the rink, and the formal exercises began when General C. H. Barney introduced Mr. James I. Gulick, chairman of the Committee on Exhibits, who, in a short speech, told the assembled throng about the previous exhibitions of the National Electric Light Associaton. At the close of Mr. Gulick's remarks, he called upon Sir Donald Smith, who, after a fine speech, that came very near being an oration, declared the exhibition formally open.

General Barney then explained that Miss Bovey, a six-year-old daughter of Professor Bovey, would touch a button which would start the machinery in motion, and would then touch another button which would turn on the lights. General Barney held the little girl up, the first button was touched, and the current supplied from the McGill University traveled over the lines and the machinery was put in motion. In a minute or so the little girl touched the second button, and the hundreds of glow lamps and arc lights burst into brilliancy, making the gas jets look like rush-lights. The advent of the light was the signal for a discordant noise produced by horns and bagpipes, with which the exhibitors had supplied themselves. After the uproar had subsided, a very good band of music commenced an interesting programme, which continued through the evening.

This was the first exhibition of the kind ever held in Montreal and was pronounced by all to be an unqualified success. A number of the prominent citizens sent in requests that the exhibition be kept open longer than the 16th, but for many reasons it was deemed inadvisible, and on the date agreed upon the exhibition will close.

EXHIBITION NOTES.

L. E. Wilcox & Company, of Meriden, Conn., exhibited the Speed wire stretcher.

Robin & Sadler, of Montreal, exhibited some excellent leather belting and belting supplies.

H. A. Rogers, of New York, dealer in machinists' and electrical supplies was well represented.

Baker & Company, the great platinum refiners of Newark, N. J., were ably represented by C. O. Baker, Jr.

The Card Electric Motor and Dynamo Company, of Cincinnati, Ohio, distributed copies of a very handsome catalogue.

The Gould Packing Company, of East Cambridge, Mass., showed samples of Gould's steam and water packing.

Mr. Louis Walsh, of the Thompson & Robertson Company, of New York, was on hand in the interest of the fibrous dry battery.

The Abendroth & Root Manufacturing Company issued a handsome illustrated pamphlet carrying the title of "Steam Boilers."

An overdue ocean steamer prevented Felten & Guilliame, of Cologne, and Cöln & Bender, of Berlin, from presenting handsome exhibits.

The Nubian Iron Enamel Company gave out circulars setting forth testimonials as to the virtues of this enamel in protecting exposed metal work.

Mr. J. W. Taylor, general manager of the Brooks Carbon Works, of Peterboro, Ontario, represented his company and renewed old friendships.

The New York Belting and Packing Company distributed a large quantity of printed matter describing their rubber goods and vulcanite emery wheels.

The National Carbon Company issued their annual directory of electric arc lighting plants, bearing date of September 1. It is better and more complete than ever.

The Dominion Wire Manufacturing Company showed copper and steel wire of various sizes, and wire nails and screws. Both covered and bare wire was shown.

There was one little space which did not seem to have much of anything in it, but on inquiry it was learned that it had been engaged as Royce & Candee's Freak Parlor.

Mr. William P. Mullan, of Boston, represented the Shultz Belting Company, of St. Louis, and showed samples of the company's leather link belts that are so well known.

The Ball Electric Light Company, of Montreal, made an exhibit of a 35 light four ampere arc dynamo, a 75 light incandescent dynamo and two 7½ horse-power Ball motors.

Wednesday night was working men's night, and the admission fee was fixed at 10 cents; Thursday afternoon was students' afternoon, with the admission at the same low price.

The *Electrical World*, the *Western Electrician* and *Electricity* had commodious headquarters in parlors at the Windsor Hotel. A number of other journals had representatives in attendance.

The Hart & Hegeman Manufacturing Company, of Hartford, Conn., was ably represented by Mr. Gerald W. Hart. A very complete line of the well-known Hart switches was exhibited.

Mr. J. Fitzgerald, of Montreal, had an exhibit of combination gas and electric fixtures, equipped with the universal bracket joint invented by himself.

The Smith & Vail Company, manufacturers of steam pumps, was represented by Mr. J. M. Duncan, of New York, who distributed printed circulars describing the merits of the pump named.

The Heisler Electric Company, of Philadelphia, had on exhibition a 200 light dynamo, which is shown in one of our illustrations in this issue. This exhibit was in charge of Oscar Hermann.

The Reliance Gauge Company, of Cleveland, Ohio, called attention to the Reliance water columns, the use of which, it is claimed, insures an economy of fuel and repairs in steam boiler plants.

Mr. R. B. Corey, the Ward arc lamp man, was present, but made no exhibit of his famous lamps, as they were included in the exhibit of the Toronto Construction and Electrical Supply Company.

The Johns-Pratt Company, of Hartford, Conn., filled a space with their various forms of Vulcabeston packings. These forms included moulded gaskets, packing rings and piston rod packings.

Manager C. D. Crandall, of the Western Electric Company, Chicago, was there. His company exhibited a remarkably fine collection of electrical house furnishing specialties and a number of other devices.

Mr. H. T. Chapman told visitors of the merits of the Russell arc lamp, made in Boston. He had on exhibition a 12 and 18 hour arc lamp, and the "Baby Russell," which is just 27 inches over all.

Mr. T. W. Ness, of Montreal, made an exhibit of electrical supplies. A new telephone switchboard, sewing machine motors, electric turn tables and a number of batteries for open circuit work, were shown.

The ELECTRICAL REVIEW occupied Parlor 102, Windsor Hotel, as headquarters, besides having a large space at the exhibition hall. The paper was represented by Chas. W. Price, Stephen L. Coles and H. T. Richards.

Robert Mitchell & Company, Montreal, made an exhibit of combination gas and electric fixtures. The designs were unique and tasteful. One chandelier was arranged to carry growing plants besides furnishing light.

The Globe Electric Cordage Works, of Philadelphia, had a large exhibit of their latest improved incandescent lamp cord, which is claimed to be absolutely fire and waterproof. Mr. H. G. Smiley was in charge.

Alexander, Barney & Chapin, New York, had an exhibit of general electrical specialties and A. B. C. lamps in Room 265, Windsor Hotel. The company was represented by President P. H. Alexander and M. H. C. Issertel.

The Fibrone Company, of New York, exhibited a very extended variety of electrical insulating devices manufactured of fibrone. Mr. Joseph Steinberger was in charge of the exhibit, which excited much comment.

The Page Belting Company, of Concord, N. H., was represented by Mr. Currier, who exhibited a line of leather belting and Acme link belts. The company issued printed matter showing views of Acme link belts in operation.

The central booth in the floor of the exhibition hall was occupied by a collection of delicate electrical instruments, placed there by McGill University. One of the most interesting of these was a chronograph operated by electricity.

The International Okonite Company, Limited, was represented by Capt. W. L. Candee, Geo. T. Manson and Jean A. Wetmore. A fine line of Okonite wires, Acme lead-covered cable, flexible cord and Manson tape was exhibited.

The Eddy Electric Company, of Windsor, Conn., was represented by Messrs. A. D. Newton and M. E. Baird, who saw that their motors shown in the exhibit of the Toronto Construction and Electrical Supply Company were properly displayed.

The Standard Electric Time Company, of New Haven, Conn., had a well arranged exhibit of their electric clocks, besides furnishing the exhibition hall with electric time. Mr. C. D. Warner, the general manager of the company, was in charge.

The "C. & C." Electric Motor Company, of New York, was represented by Mr. H. L. Lufkin. A remarkably handsome catalogue of their latest motors was distributed and created considerable comment, owing to its beauty and tasteful appearance.

The Electric Merchandise Company, of Chicago, had a fine parlor at the Windsor Hotel, where the Burton heater and a number of street railway specialties were on exhibition. Messrs. D. B. Dean and W. R. B. Willcox did the honors.

Secretary Beane's office was a busy place, and the secretary and his assistants, Miss Harriet Billings, of New York, and Misses Slinn, Fletcher and Crowley, of Montreal, are to be complimented on the affability which they displayed under all circumstances.

H. Ward Leonard & Company, of New York, were represented by Messrs. Leonard and Vance. An Edison hoist coupled directly to an Edison motor was shown. The hoist was kept in constant operation, raising and lowering from the floor to the ceiling a box advertising sign.

James W. Queen & Company, of Philadelphia, had a small exhibit, including a newly designed Siemens' electro-dynamometer, a new portable testing set, and a combined portable galvanometer and battery for locating faults. Mr. E. G. Willyoung represented the company.

The Eugene F. Phillips Electrical Works, Limited, had a parlor in the Windsor Hotel, in addition to a large space in the exhibition hall. This exhibit was most artistic, the magical name of "Phillips" appearing in a brilliant setting of incandescent lamps that attracted the attention of every one.

The Canadian Electric Construction Manufacturing and Supply Company made an exhibit of electrical specialties and supplies, including Simplex wires and the Hascltine arc lamp carbon protector. Mr. A. J. Corriveau devoted as much time to the exhibit as his other engagements would permit.

The Delaware Hard Fibre Company, of Wilmington, Del., showed a wonderful variety of insulating pieces made of their materials. The exhibit included gears, threaded pieces, nuts, socket pieces, canes, tool handles and others. Mr. W. H. Stanhope conscientiously represented his company.

Pass & Seymour, of Syracuse, N. Y., made a fine exhibit of electrical chinaware. Some of the pieces were made in imitation of various hard woods. It is said that they have shipped over one million small pieces of china in nine months, and are now shipping an average of nearly 400,000 pieces a month.

The New York Insulated Wire Company made a fine showing of the Vulca electric wire ducts and Grimshaw wires and cables. The exhibit included a complete fishing system, showing junction, distributing and angle boxes. The company was represented by Messrs. Godfrey, Place, Dowse, Meeker and Noll.

The Phœnix Glass Company, of Pittsburgh, Pa., had one of the handsomest exhibits in the hall. Electrical glass of all kinds was shown in the greatest profusion. There were some especially handsome examples of fine cut glass globes. Messrs. A. H. Patterson and E. H. Peck were in attendance.

The Bell Telephone Company of Canada, represented by W. J. Gilmore, had installed a telephone in the exhibition hall, and one in the parlor of the Eugene F. Phillips Electrical Works, at the Windsor Hotel. The telephone service was free to delegates and was taken advantage of to a considerable extent.

The Robinson radial car truck, equipped with two 15 horse-power Thomson-Houston single reduction motors, was exhibited in the space occupied by the Thomson-Houston International Electric Company. The truck was one designed for a long car and was fitted with six wheels, the whole truck being placed on a curve.

The Bernstein Electric Company, of Boston, made an exhibit showing how the Bernstein lamp can be used for house, store and street lighting. Bernstein incandescent lamps of 25, 30 and 50 candle-power were shown on Ball arc light circuits. The company was represented by Mr. Henry B. Cram and George B. Lean.

The Ferracute Machine Company, of Bridgeton, N. J., made an exhibit of prints and drawings of a large number of machine tools used in electrical work. They had expected to have some of their machines in operation, but could not arrange for power. Mr. Fred. F. Smith, secretary of the company, was in attendance.

The Laboiteaux Electric Motor and Fan Company, of Cincinnati, Ohio, was represented by Mr. F. M. Laboiteaux. A fan motor of unique construction was shown. The motor was hung a little off the center, so that in one instance it oscillated and in the other it revolved, thus distributing the current of air which it generated.

The Standard Paint Company, of New York, exhibited cans of P. & B. paints, P. & B. tape, P. & B. insulating paper, P. & B. armature varnish, and a miniature station roof covered with P. & B. roofing paint. The whole exhibit was surmounted by a game cock, the trade-mark of the company, an electric lamp glowing in his beak. Messrs. Shainewald, De Ronde and Castle were present.

The Norwich Insulated Wire Company had reserved a nice space for an exhibit of their wires and cables with paper insulation. The general sales agent, Mr. F. D. Voorhees, was in attendance, but the exhibit was delayed in transit. Toward the end of the week, however, Mr. Voorhees was able to obtain his goods, and made a handsome display.

The Consolidated Electric Manufacturing Company, of Boston, made an exhibit of a number of large jack-knife switches for street railway use, electric door openers, and the Wade dynamo register. This device is designed to watch the dynamo tender, and automatically records the working of every circuit. The company was represented by Mr. C. E. Bibber.

The E. S. Greeley & Company, of New York, occupied a large space at the rear end of the hall. They had on exhibition everything electrical, including a large number of specialties and a handsome line of instruments. The Frey galvanometers occupied a prominent position. The company was represented by Messrs. T. J. Smith and Charles P. Frey.

The Standard Underground Cable Company, of Pittsburgh, had the initials of the company formed of wire samples neatly displayed on a table. This company also distributed its valuable and well known engineers' pocket book. Vice President and General Manager Marsh was there in the interests of the company, as was also Manager George L. Wiley, of New York.

The Eureka Tempered Copper Company, of North East, Pa., was represented by Messrs. N. S. Possons and G. R. Phillips. Their material was shown worked up into pinions, brushes, trolley wheels, wire, bushings, gongs and bells. Mr. Possons also had with him the John Scott legacy medal, recently awarded to the inventor of the process used by the Eureka Company.

The Electrical Engineering and Supply Company, of Syracuse, N. Y., made an ex-

hibit which is shown in one of our illustrations. Messrs. F. H. Leonard, D. J. McIntyre and F. M. Hawkins were in charge. The exhibit included new combination ceiling rosettes, sockets and cut-outs for all systems, and large central station switches. The Packard incandescent lamp and Jenney electric motors were prominently displayed.

Chas. A. Schieren & Company, of New York, had trouble in getting their exhibit through the Custom House, but after a short delay were enabled to show their perforated electric leather belts to anybody who wished to see them. Besides the regular exhibit, the fact that the belting was in use on a number of motors in other exhibits, was sufficient in itself. The company was ably represented by Chas. A. Schieren, Jr., of New York.

The Toronto Construction and Electrical Supply Company, of Toronto, had a large space on the left of the main entrance, in which were shown Ward arc lamps, Grimshaw cables and wires, Partrick & Carter household electrical goods, Samson batteries, Eddy motors, measuring instruments, etc. Mr. Frederic Nicholls, general manager of the company, Mr. George C. Stannard and Mr. A. J. Christie, of St. Johns, N. B., were in charge.

The Crocker-Wheeler Electric Motor Company, of New York, was ably represented by Dr. S. S. Wheeler and Mr. George W. La Rue. Theirs was one of the best small power exhibits. They showed a 24 inch La Rue exhaust fan running at 600 revolutions per minute, a one horse-power arc motor with the company's new centrifugal governor attached, a one-sixth horse-power constant current motor regulated by hand, and several new auxiliary devices.

The Germania Electric Company, of Boston, had in attendance Mr. O. K. Stuart and H. Bottomley. The improved Schaefer double carbon lamp in various colors was shown, as was also a matted lamp, frosted by a chemical process, some colored lamps which will withstand the hot steam test, the Germania shadeholder, and the Walter K. Freeman transformer, of which this company is the sole manufacturer.

The Weston Electrical Instrument Company, of Newark, N. J., made a beautiful display of Weston standard instruments, including a new portable alternating current voltmeter, which is guaranteed to be correct to one-fifth of one per cent., and a new 1,500 ampere meter for station use, guaranteed correct to within one per cent., was also shown, besides the usual standard types which are so well known. The exhibit was in charge of Wallace M. Hill and William Moore.

The Jewell Belting Company, of Hartford, Conn., occupied a space fitted up as a parlor, where printed matter of interest was distributed. One pamphlet, entitled "How Made, What It Has Done, What It Will Do," was in great demand, as it contained a number of valuable points on belting. The exhibit of belting and belting supplies was in charge of Mr. C. L. Tolles, who also distributed a large number of bill holders and leather match safes made by the Jewell Company.

The Bryant Electric Company, of Bridgeport, Conn., made a fine display, which was looked after by Manager W. C. Bryant. They make a specialty of sockets and a full line for every system was exhibited. Their new single pole switch and lamp pendant attracted much notice. Many favorable comments were passed upon the beautiful new catalogue which has just been prepared for this company by Bartlett & Company, of New York. It is extremely tasteful and well arranged.

The Canadian press did everything in its power to interest the Canadian public in the work of the National Electric Light Association, and a large attendance at the skating rink was one of the direct results. The press committee consisted of Messrs. James Harper of the *Witness*, George Miller of the *Star*, Hervey of the *Trade Review*, Tetu of *Le Monde*, Richard White and R. R. Samuel of the *Gazette*, J. Wilson Smith of the *Insurance Chronicle*, and A. Boyd of the *Toronto Mail*.

The Ries Electric Specialty Company, of Baltimore, had an exhibit in the main entrance, of their new regulating socket for incandescent lamps. It is claimed that the socket is designed so that the current consumed by the lamp is proportional to the light given. By the use of this socket the incandescent lamp is possessed of one thing it lacks, that is, the ability to turn the light up and down. This was one of the specialties shown, and Messrs. Elias E. Ries and Louis S. Greenfelder had their time fully occupied in explaining it.

The Eugene F. Phillips Electrical Works made a fine display of wires and cables, surmounted by a large sign consisting of incandescent lamps in the form of the word "Phillips." Some very handsome coils of line wire and cable were shown, besides spools of No. 36 magnet wire, drawn and covered at the above-named works. Mr. John Carroll was in charge. Messrs. Eugene F. Phillips, P. C. Ackerman, W. A. Hathaway and E. Rowland Phillips, of the American Electrical Works, Providence, were on hand to assist Mr. Carroll in showing off the products of the Eugene F. Phillips Electrical Works.

Commodious press headquarters were provided in the rear of the hall. The Great Northwest Telegraph Company, The Western Union, the Anglo-American Cable Company and the Canadian Pacific Telegraph Company had offices, and operators in attendance. Mr. Charles R. Hosmer, general manager of the Canadian Pacific Telegraph Company, informed President Huntley that messages sent over his lines by members of the Association would be franked, and that he was authorized by Mr. A. B. Chandler, president of the Postal Telegraph Company, to offer the same privilege over the Postal lines. These courtesies were much appreciated and were taken advantage of to a considerable extent.

The Interior Conduit and Insulation Company, of New York, made a fine showing of their new metal-covered interior tubes, which showed in a perfectly plain manner, the great adaptability of this system to house wiring. The company's underground conduit system was also shown. Besides this there was a new snap switch of entirely novel design, the 50 ampere size being about 3 inches in diameter. The exhibit was lighted in part by the California arc lamp, which is very unique in construction. The carbons are flat and made in the form of sectors of a circle, which are kept in contact by springs. The lamp will burn 90 hours without renewing the carbons. General Manager E. P. Little and Assistant Electrician Paul Oscanyon were in charge.

The Fort Wayne Electric Company's exhibit is shown in one of our illustrations in this issue. Mr. W. J. Morrison, agent for New York State and Canada, represented the company, in addition to the great amount of work he was doing on the various entertainment and citizens' committees. The Fort Wayne exhibit included a 750 light compound wound Slattery alternating dynamo and a 15 light Wood arc machine. The Wood machine has been presented to McGill University. A temporary plant erected in the basement of the Windsor Hotel furnished power to two Thomson-Houston motors, which were connected with Slattery and Wood dynamos by Schieren "Electric" perforated belts. The Fort Wayne exhibit was much admired, the machines presenting a very handsome appearance.

The exhibit of the Edison General Electric Company was in charge of the Canadian District office. All the apparatus shown was made by the Edison factories at Peterboro and Hamilton, Canada. Our illustrations show two views of the exhibit. Messrs. Barr and Corbett, of Montreal, were in attendance, besides a number of prominent Edison officials from New York; these included Messrs. Insull, Muir, Shain, Stieringer and Green. This was the largest and finest exhibit shown, occupying about half of the main floor of the rink. Nearly everything manufactured by the various Edison factories was shown. The exhibit included an underground system, generators, measuring instruments, controlling switches, wires and cables, motors, hoists, rock drills, pumps, ventilators and railway trucks. There were also sample boards of lamps, sockets, wire, switches, etc. Two of the largest dynamos had cards attached to them, showing that they had been presented to McGill University.

The International Thomson-Houston Electric Company's exhibit is shown in an illustration which we present in this issue. Mr. George W. Daveaport and his assistants were in charge of this exhibit, which was one of the largest in the hall, occupying a very large space. The exhibit was really in two parts, one being the generating apparatus at the McGill University, from which place power was transmitted to the motors and various dynamos at the Victoria Skating Rink, nearly a mile distant. At the McGill University the plant consisted of a 12½ by 12 McIntosh & Seymour engine and two 50 horse-power series shunt wound 500 volt Thomson-Houston generators. The machines were compounded for a drop of 10 per cent. in the line, thus being enabled to deliver current at the rink at 500 volts. The exhibit included a full line of measuring devices, including the famous Thomson watt meter, Thomson-Houston motors, Excelsior arc dynamo, Thomson-Houston alternating dynamo, electric drills, electric hoists, transformers, station devices and porcelain specialties and supplies. This company also presented to the McGill University one of the dynamos exhibited.

Among the scientific and technical visitors to the Montreal exhibition much interest was created by the exhibit of The E. S. Greeley & Company, of New York, in the distinctively pronounced character of their display in standard measurement apparatus, embracing, as it did, their American pattern of the Thomson galvanometer with various modifications and patented improvements; also several types of galvanometers, such as the Western Union standard, Helmholtz-Gaugain, half meter ring, sine and tangent combined, and, particularly, a model of a new form of ballistic galvanometer, which has not yet been placed upon the market; in fact, a line in galvanometers so complete as to fill every requirement in all departments of electrical measurement.

No less complete was the display of rheostats, testing sets, high resistance boxes, many of which latter are of new design, in addition to their regular advertised lines of portable apparatus and standard resistance boxes.

The telegraph department was represented by the renowned prize-winning Victor telegraph key, with sounders, relays, switches and incidental apparatus innumerable. Their improved ink recording register is deserving of special mention, as it is so justly a favorite in Morse, district telegraph and fire alarm work, owing to its accuracy and reliability. A peculiarity in the service of this register is its employment on railroad and other telegraph lines in the capacity of a "tell-tale," as its provisions for self-starting and self-stopping enable it to make a complete record of all that transpires on the wire during the day without wastage of space or paper, and permits each day's work to be filed away, a complete record for future reference.

In addition to the above was a full line of electric light and power appliances, amply testifying in their character and number not only to the difficulties of keeping pace with electrical progress in this direction, but also the fact that the Greeley Company succeeds in doing it.

Electric bell, burglar and fire alarm and general house supplies, with their annunciators, push buttons and other paraphernalia, were displayed in full force.

Of the only two primary batteries put on exhibition at Montreal, one was presented by the Greeley exhibitors, and that one was the now well-known Champion battery which for the past year has been exciting the attention of all users of this class of goods.

It was remarked by Custom House officials that outside of those exhibiting such expensive apparatus as large dynamos and motors, the Greeley exhibit probably intrinsically represented the highest value of any contribution sent into the country, while the decorations of their booth was everything that taste, skill, patriotism and liberality would suggest.

H. Ward Leonard & Company exhibited the most radical improvement in the operation of electric motors which has been produced for years. A standard shunt wound motor is made to operate at any speed, from a movement that is scarcely visible to that of 2,000 revolutions per minute, and yet at any rate of speed between these limits the speed is automatically held constant, entirely independently of the load being moved. In addition to this control of the speed and torque the direction of rotation is under perfect control, and while running at any speed and at any torque with the capacity of the motor the direction of rotation can be instantly reversed and the speed in the reverse direction will be the same as before.

The result is entirely new, not only as regards electric motors, but even as regards all motors. Claims are made as follows:

No motor has heretofore existed which could be operated at any desired speed, and, automatically, at any speed independently of the load. By Mr. Leonard's invention it is possible to operate at any speed, regardless of variations in the torque and direction of rotation, and also to operate at any desired constant torque, the speed varying automatically to the requirements of the work at such torque.

It is also possible to take any specified amount of horse-power and, under this principle convert it into any desired pull with the corresponding speed, so that the consumption of power is entirely independent of the load to be moved.

The application of this principle is almost unlimited. Applications which immediately suggest themselves are railways, elevators, pumps, cranes, mining hoists, ventilating fans and similar familiar cases, in which it is desirable to control both the speed and the pull of the motor.

The entire control is effected through a current carried by a flexible incandescent lamp cord, and no special apparatus of any kind is required to apply the principle. Mr. Leonard can operate, in the manner described, any shunt motor on the market. He is not able to give the details of his method, on account of not as yet having secured full protection in the shape of foreign patents.

He hopes, however, in the course of about a month, to publish a full description of the method by which he accomplishes these astonishing results.

The Berlin authorities are discussing a project for the construction of elevated railroads with electricity for the motive power, running throughout Berlin and suburbs. The system is to include eight lines, making a total of 56 kilometers in length, and the cost is estimated at 84,000,000 marks.

LONG DISTANCE POWER TRANSMISSION AT FRANKFORT.

The Transmission of Power by Alternating Currents Differing in Phase (Rotary Currents).

[Von Dolivo-Dobrowolsky, in *Elektrotechnische Zeitschrift*.]

The development of the industries in general, and of the electrical industries in particular, is continually increasing the importance of the transmission of power by electricity. At the time of the Munich electrical exhibition the experiments of Marcel Deprez were very warmly welcomed, and there was an impression at the time that great things might be expected of them. For several years, however, no progress in this branch was made, the cause being the low efficiency and insecurity of the dynamos of that date, but from 1886 to 1888 the so-called English school of electrical engineers made such improvements in dynamos as to render possible the transmission of power on a large scale. During this time the Oerlikon Maschinenfabrik did great service in this direction, but continuous currents, on account of the delicacy of the commutator and the difficulty of transformation, being little suited for distribution and transmission of power over long distances, the hopes of engineers have hitherto remained unfulfilled. The construction of a continuous current machine to supply energy at 10,000 to 20,000 volts to single motors and to lamps is at present almost an impossibility, and will certainly remain so.

Although we do not wish to deny the many good qualities of the continuous current, we think the alternating current alone suited for the distribution of power on a large scale over long distances. But until recently there has been no practical alternating current motor, and it is to this point that the attention of engineers and scientists has been directed. All their efforts produced no result until 1888, which must be looked upon as the year of the birth of the distribution of power by alternating currents. The discovery of Ferraris and the investigations of Schallenberger and Tesla were published at this time, whilst many others were working on the use of alternating currents differing in phase, without, however, any practical result being reached. Tesla's motor, which attracted so much attention when it came out, does not seem to have fulfilled anticipations, as no commercial application of it has yet been made. As will be seen later, Tesla's arrangement with two quite independent currents, differing 90 deg. in phase, possessed little advantage; its faults were avoided in the arrangements of other inventors, and motors with a larger number of alternating currents were simultaneously worked out by Bradley, Haselwander, Wenstrom and the present writer.

Tesla's motor, as is well known, consists of a magnet ring carrying two sets of bobbins. These two sets are supplied by two alternating currents differing in phase by 90 deg. The result is a rotating magnetic field in the interior of the ring (a so-called "Ferraris," or rotating field), which accordingly acts almost exactly as if a constant magnetic field were mechanically revolved in it. On this principle extremely simple motors, without either sliding contacts or brushes, can be built. As a matter of fact, mistakes have often been made recently with regard to the Tesla motor. The following consideration will show that it cannot act in a particularly satisfactory manner. Each of the two currents displaced by a quarter-phase exerts a magnetizing force, which at any moment is equivalent to the product of the number of turns and the current strength at the moment. The total magnetizing force exciting the motor magnet is equal to the sum of both sets of ampere turns, and is, consequently, also a function of the sum of the two currents. Now, in practice, this sum is never constant. It is true that in Ferraris' arrangement the resultant force of the two sets of coils at right angles to one another on a mathematical magnetic pole must be considered constant, but this cannot be applied to material motors where the ordinary rules of electro-magnets come into force. The currents being displaced by 90 deg. their sum varies between the limits i and $2i \sin 45$ deg., i being the maximum value of each current. When either current has this maximum value, the other is zero, and their sum is, consequently, equal to i. When the two currents are equal, as at the time t, each is equal to $i \sin 45$ deg., and their sum is, therefore, $1.4i$. The total number of ampere turns, to which the excitation of the motor is due, therefore varies as much as 40 per cent. of its least value,

so that the magnetic field of Tesla's motor is not merely rotating, but also pulsating to a very considerable extent. The action of the motor is accordingly far from being so simple as it at first sight appears. It is possible, with the help of Elihu Thomson's alternating motor, to consider the two properties of the field separately. The motor consists of a magnetic field due to an alternating current and an armature, of which the windings form closed circuits. Like all synchronous alternating current motors, it must be brought up carefully to the proper number of revolutions per minute before the alternating current takes up the work. If overloaded, it comes to a sudden standstill, for the pulsations of the field only serve to turn the armature when it is going at a particular speed. If this is not reached they not only check, but absolutely stop rotation, because the currents induced in the closed circuit armature do not correspond properly in time and direction to the field, so that it is very difficult to start such an armature in an alternating field. Now, a Tesla motor, or, in general, a two-phase motor, as we have seen above, has a magnetic field which pulsates 40 per cent. in intensity, and it must, therefore, to a partial extent, possess the same properties as Thomson's motor. Whenever

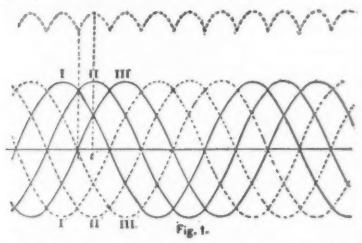


Fig. 1.

Tesla's closed-circuit armature is not moving synchronously, the torque is only equivalent to the difference between the effect of its rotating field and the checking due to the pulsation of the magnetism. The motor, therefore, does not run well under load, and exhibits at full speed a tendency to synchronism up to a certain limit of load, beyond which its speed and torque rapidly diminish. The usefulness of the motor is, therefore, limited, and it can only be regarded as an improvement on the perfectly synchronous motor of Thomson, by reason of its power of starting under a heavy load when the circuit is closed.

A good motor, free from the faults accompanying synchronism, can only be produced on the principle of the rotary current by reducing the intensity of the pulsations of the magnetic field. The ideal field is absolutely constant, the lines of force rotating in exactly the same way as when a continuous current magnet is rotated. This ideal is approached by increasing the number of currents, of which the phases are made to follow one another. At the same time it is not necessary to use very many currents. A glance at Fig. 1 will show, even in the case of three currents, the sum is sufficiently constant. At the time t, the sum is equal to 2 sin 60 deg. $\times i = 1.732\ i$, i being the maximum value of each current. And at the time t_1, the sum is 2 sin 30 deg. $\times i = 2\ i$. The pulsation of the field, which this variation of the sum of the currents involves, is, with three currents, therefore, only 15 per cent., instead of 40, as in Tesla's motor. The number of alternations being relatively small, the saturation of the iron can be carried up to a high degree without impairing the efficiency, so that, for a variation of 15 per cent. in the ampere turns, the quantity of magnetism remains practically constant.

Ordinarily, the increased number of conducting wires would constitute an obstacle to the practical application of the transmission of three separate currents differing by 60 deg. in phase. Even if it be granted that, owing to improvements in dynamo, three currents could be conveyed by four conductors analogous to Tesla's three wires for conducting two currents, these four con-

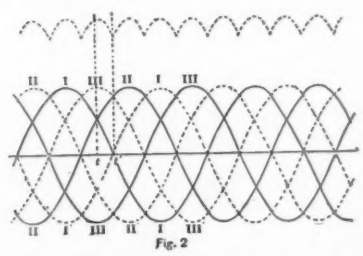


Fig. 2

ductors would still be too costly. A simple arrangement allows the three currents to be conveyed by three conductors, and without using any more copper than that required for the Ferraris-Tesla device. This is made possible by supplying three currents differing by 120 deg., instead of 60 deg., in phase, and is effected by reversing the connections of the bobbin which supplies one current. To each of the circuits in the motor correspond at least two oppositely wound coils producing opposite poles, so that we may also add the curves obtained by reversing the signs. Fig. 1 thus becomes transformed to Fig. 2. This figure represents the three currents differing in phase by 120 deg., and is quite analogous to Fig. 1, in which the phase difference is 60 deg.

Considering Fig. 2 more closely, we find that at the time t the sum of the currents I and II = 2 sin 30 deg. $\times\ i$, whilst III = i so that since sin 30 deg. = 0.5, I + II = III.

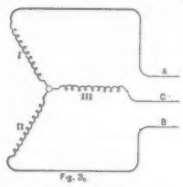


Fig. 3.

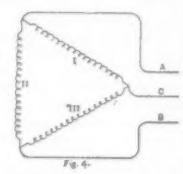


Fig. 4.

At the same time t^1 again I O II is proportional to sin 60 deg. and III to sin 120 deg., so that I + II = III. Generally, a similar relation holds good at any time, as may be seen from the fact that the currents are sinoidal. Each of the currents (or pressures) is equivalent and opposite to the sum of the other two, so that their algebraic sum is always equal to zero, whilst the sum of their absolute values, as above observed, varies between 2 i and 1.732 i. From the fact that the algebraic sum of the three currents or pressures at any moment is zero, it follows, from Kirchhoff's laws, that one current can be connected either in series with or parallel to the other two. This gives two methods of connecting, which are set forth diagrammatically in Figs. 3 and 4. We call the former arrangement the "open," the latter the "closed" connection. This connection renders possible the conveyance of the three currents through three conductors, in that the current flowing in one conductor finds its way back to the other two. A similar system can also naturally be employed in the case of more than three currents being used; it was independently and simultaneously found out by Bradley, Wenstrom, Haselwander and the present writer.

In the course of the careful experiments carried out by the author with the Allgemeine Elektricitats Gesellschaft, in working out the details of the system, there appeared many cogent reasons for abandoning this simple arrangement. Amongst these were the small output and consequent low efficiency, the heavy cost of dynamos and motors, the difficulty of regulating and measuring the currents in the three connected circuits and of controlling them, etc.

The following system is now being generally applied by the Allgemeine Elektricitats Gesellschaft. The dynamos supply several

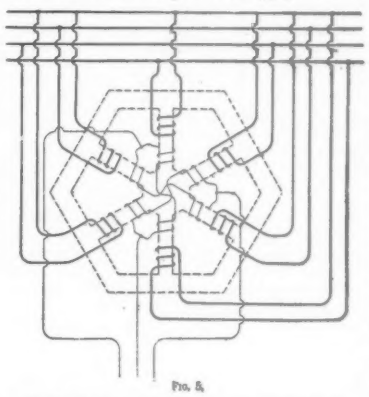


Fig. 5.

perfectly independent currents, usually six, although any number may be adopted. A large number of currents enables the dynamos to be used to the best advantage in that the whole circumference of the armature can be covered with active turns which, as is well known, cannot be effected with ordinary alternators. An increase in the output in relation to size is also rendered possible from the fact that a multiple phase machine gives out energy continuously, whilst ordinary alternators only pulsate. The energy flowing in the conductors is also constant, since, as above pointed out, the arithmetical sum of the separate currents is practically constant, just as in the case of the continuous current. The distinct unconnected currents supplied by the machine are carried separately through switches, regulators and measuring instruments, and then combined by suitable transformers into three connected currents differing by 120 deg. in phase. These are conveyed wherever they are required, and finally again split up in order to be utilized. The transformer depends upon the rotation, by means of the rotary current, of a magnetic field inside a closed iron ring without poles, whilst the compound current supplied from the machine excites in the secondary coils similar current impulses following behind one another. The transformation corresponds to the action that takes place in a rotating current dynamo, except that in the transformer the field rotates about fixed coils, whilst in the dynamo the armature is mechanically rotated in a fixed field.

Since in the transformer three connected currents, differing by 120 deg. in phase, have been produced, the idea will at once occur that the same loss will again take place as in the case of the currents directly connected. This is, however, not true. Certainly, in consequence of the connection, 15 per cent. loss in pressure takes place, and the transformation ratio is not equal to that between the number of turns, but it is only necessary to increase the number of turns in the secondary by 15 per cent. in order to fully utilize the primary currents. The efficiency of the transformer is consequently only very slightly effected. As a general rule the loss in transformation and the cost of transformers are not of great importance, since it is generally preferable to build machines for a relatively low voltage and to transform the energy to a high voltage before supplying it to the conducting wires. A dynamo for from 50 to 100 volts can be built so much more cheaply and safely that a transformer pays for itself, and the low pressure machine works so much more economically that the three or four per cent. loss in the transformer is balanced. It is hardly necessary to point out that this mode of procedure is generally the only one applicable in the case of very high pressure, exceeding 10,000 volts.

Fig. 5 shows a diagram of one of the numerous arrangements possible for a rotary current transformer, in which the six sepa-

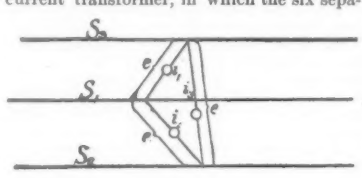


FIG. 6.

rate primary currents are transformed into three connected currents. The behavior of the connected currents of the secondary winding is a reproduction of that of those in the separate primary circuits, so that the regulation of current and tension is perfectly simple. By the connection of the secondary currents we also secure the advantage that the long and, therefore, expensive conductors need only be three, instead of four in number. At the second transformation at the receiving station, it is preferable for the object of running large motors, just as for lamps, to resolve the combined currents again, for reasons similar to those which apply to dynamos.

It will now be pointed out that the weight of the conductor required for equal energy is not greater for the three wires of the rotary current system than for the two wires of the ordinary system. In order to determine the conductor section for a combined rotary current, such as is used in transmitting power over a long distance, it is first of all necessary to obtain a clear idea as to the amount of energy conveyed. The solution must be obtained in the same way as in the case of an ordinary alternating current, and we, therefore, assume that there is no self induction, and therefore no displacement of current with reference to electromotive force. If self-induction does exist the same modifications that occur with an alternating current also present themselves with a rotary current. Moreover, we will consider the case in which each pair of the three conductors is equally loaded, since only the full normal load may be considered in determining the section of the conductor. Fig. 6 shows a conductor with a combined rotary current, the current strength being I and the pressure e. By I we mean either the maximum or the effective or the mean current strength, and not the momentary strength. The loading is effected by the three equal branches, i_1, i_2 and i_3. The course of the current, as we have above

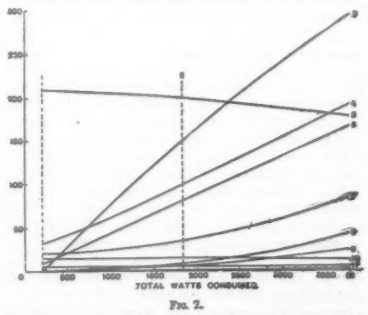


FIG. 7.

proved, is always such that each current finds its way back by the other two conductors, and that the current maxima in the three conductors follow one another at intervals of 120 deg. I_1 is consequently split up between i_2 and i_3, I_2 between i_1 and i_3, etc., so that there is an interval of 60 deg. between i_1 and i_2. Hence $I = 1.732\ i$. From this we also see that the maxima of the current I do not coincide with those of i, but that the maximum of I_1 lies midway between those of i_2 and i_3, the resultant current I being 30 deg. removed from the separate currents i.

From the above assumption, that the apparatus does not possess self-induction, no difference in phase takes place between the electromotive force and the current to which it gives rise, so that the current i appears simultaneously with the pressure e. On the other hand, between e and I there is a phase interval of 30 deg., since i and I differ from one another by this amount. In other words, there exists in combined three phase currents a phase interval of 30 deg. between the current in one main conductor and the pressure between the other two. The total energy is equal to 3 i e, that is, to three times the energy in each branch. If, now,

$$\text{we put for } i \text{ its value} \frac{I}{2 \sin 60 \text{ deg.}}, \text{ we get}$$

$$\text{for the total energy } 3\ i\ e = 3\ e \frac{I}{2 \sin 60 \text{ deg.}}$$

$= 1.732\ I\ e$; that is to say: If the combined rotary current carries in each of the three conductors an effective current strength I with the pressure e, the energy transmitted is 1.732 I e. If, now, we wish to convey the same amount of energy with a continuous or alternating current, the effective strength thereof must be made equal to 1.732 I. But for equal lengths of conductor and equal loss of pressure the section must be taken proportional to the current strength, whence it follows that if in the case of a rotary current of strength, I, each of the three conductors has a section equal to q, for a continuous or alternating current, two conductors each of section 1.732 q are necessary. Consequently, the total section can be reduced by about 13 or 14 per cent. Also from the observations given above as to the proportion between the currents in mains and the branch conductors, it will be seen that for each ampere in the three mains carrying the combined rotary current .866 ampere are obtained in each of the branch wires, or, that a rotating current of one ampere is resolved into three alternating currents of .866 ampere and of the same pressure, so that one ampere of a rotatory current at 100 volts represents 173.2 watts. We repeat that these relations hold good only when, (1) an equal load is thrown on to each of the three branches; (2) the load is without self-induction; and (3) the measurements are taken by separate ammeters and voltmeters, and not by a watt-meter. In the latter case, the product I e will appear smaller, since, as mentioned above, a constant difference of phase of 30 deg. exists between I and e.

These conclusions have very little value in actual work, since, practically, the first of the three conditions never, or very seldom, holds good. Moreover, in the rotary current central station the currents are uncombined and independent, as above

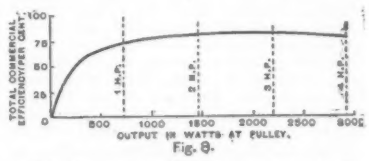


Fig. 8.

explained, so that the control of the loads can be very simply effected by the electrician in charge. The measurement of the consumption at the receiving station is also easy, the combined current being there resolved again into its components. The lamps are placed on two mains only, and are taken account of by simple recording apparatus, whilst the large motors are placed on separate circuits, and their consumption is measured by suitable watt-meters. For small motors supplied with the combined rotary current, the measurement of one current is sufficient without any correction, for the inequality in the separate circuits.

The electromotors, as above mentioned, are constructed upon the Ferraris-Tesla principle, that is to say, the different multiple phase currents produce a rotating magnetic field of nearly constant intensity, and this rotating field forces an armature with closed coils, or some similar arrangement to revolve with it. Different arrangements are adopted, according to the special conditions and the size of the motors. The very small ones (up to ¼ horse-power) are constructed with a circular magnet concentric with the armature, having internal Pacinotti projections, the coils filling the space between the teeth. The armature consists of a massive iron cylinder, with numerous holes bored through it parallel to the axis; through these pass copper wires, connected at the extremities by means of two end plates, or rings, of high conductivity copper.

In another type of motor a transformer is employed, fed by three wires carrying three combined high pressure rotary currents, and which supplies from its secondary double

the number of currents of very low voltage, the phases of which follow close after one another. When a motor is not required to be built for specially high pressure, but is to be worked by a low pressure current (say of 100 volts), such as is used in the mains of a town, it is advisable, especially for motors of over one horse-power, to employ another type by which a transformation is avoided. In working out this third type of motor, the first aim was to obtain a high efficiency, since in these cases the energy has to be paid for by the consumer, according to the reading of a watt-meter, and at a pretty high rate. The arrangement of this type is practically an inversion of the first. The magnet is placed inside, and rotates whilst the closed circuit armature is fixed.

We see, then, that the rotating current motors, so far as concerns their construction, are extremely simple; we will now show from some tests carried out that, as regards performance and economy, they must be placed above the best direct current motors. Fig. 7 shows graphically the result of tests on a two horse-power motor of the tyye last described for 70 volts and 35 complete periods per second. The tests were carried much higher than the normal allowance load, in order to determine the behavior of the machine under excessive load and abnormal conditions. The weight of the motor was about 165 kilogrammes, and, from several trials, it appeared that a load of two horse-power, after a long run, only heated it to a slight extent. In the interests of durability and safety this was fixed as the normal load. Since the motor can be allowed to run for a short time at double the load, it is clear that the limit taken is perfectly safe. From the weight and the curve of efficiency it appears that this load is by no means relatively low. From the curve in Fig. 7 we see that the motor is absolutely devoid of synchronism, the number of revolutions, when running at no load being below that calculated from the number of alterations. Then between no load and the maximum the number of revolutions only falls about six per cent., an amount which, for a two horse-power motor, is quite unimportant, and certainly below that which occurs in any direct current motor under similar circumstances. Although the speed falls off more quickly as the load is increased, it is noteworthy that at 100 per cent. overload the speed is still fairly high, and the property that alternating motors have of coming to rest when overloaded is quite done away with. From the same table we see that, starting from 205 watts, which are required when running light, the utilizable work rises nearly in proportion with the electrical energy consumed, certainly up to three horse-power, from which point, perhaps, the proportion falls off. The output at the pulley is given in watts, in order to facilitate its comparison with the electrical values. The losses in the motor, as in every electrical machine are of three kinds. (1) Loss in the copper ($i^2 r$) in magnet and armature. (2) Magnetic losses—hysteresis and Foucault currents. (3) Mechanical losses—friction of air and bearings. All these losses in the motor are carefully determined separately, and plotted out in Fig. 7 as functions of the watts consumed by the motor. We see from these curves that the loss in the copper rises pretty quickly as the load is increased; it is these losses which tend to make the curve of efficiency fall off with an increased load. The loss from air and bearing friction is approximately constant, and the slight inclination of the corresponding curve towards the axis of abscissæ is due to the fall in the number of revolutions. The hysteresis and Foucault currents in the iron of the magnet are also nearly constant, falling only slightly toward the end of the curve. Hysteresis in the fixed armature, on the contrary, continually increases, because the reversals of polarity in the armature, as already explained, depend upon the "slipping" of the motor, that is, to the difference between the number of revolutions of the motor and of the lines of force. The above losses are shown, both added and separately, in Fig. 7. The proportion between the available output and the watts consumed gives the total efficiency of the motor and is plotted out in Fig. 8. The output in watts at the motor pulley are taken as abscissæ, and ordinates are drawn at the points corresponding to one, two, three and four horse-power. We see from this curve that even at one horse-power (half load) the efficiency reaches 75 per cent., at normal load, two horse-power, it is over 80, and reaches its maximum, 81.4 per cent., at about 2.3 horse-power. From the flatness of the curve it is obvious that the economical regulation of the motor is very good, and that overloading, which is unavoidable in practice, and if it lasts only a short time does not damage the motor, has very little effect on its efficiency. A comparison with direct current motors shows clearly that rotary current motors of the same size are a distinct advance in point of capacity and efficiency. It may further be pointed out that rotary current motors can start from any position with considerable force, so that no friction or other coupling is necessary.

The two horse-power motor above referred to was tested as to its capability of starting under a load in the following way: It was coupled direct to a direct current dynamo, the field of which was independently excited, so that a load existed as soon as motion commenced. The armature of the dynamo was connected to a circuit, the resistance of which was such that the motor at full speed was carrying more than double load. The rotary current was then suddenly thrown on, and starting was found only to take up two or three seconds. The reversal of the direction of rotation of the motor with the dynamo coupled thereto (presenting a considerable amount of inertia) was effected in about four seconds. If the load was entirely taken off, the starting of the motor by itself required no appreciable time (without resistances), and no noise was caused, it being hardly possible to hear the motor when running, even when quite close to it.

In conclusion, we will point out a very valuable property of rotary current motors, as compared with many other alternating motors. When loaded there is only a very small difference in phase between current and electromotive force, so that the proportion between the watts actually consumed in work and the apparent watts is nearly equal to unity; the conductors also do not have to be made of any larger section than corresponds to the same capacity for direct currents. From the current in the magnet (Fig. 7), which holds for one of the three circuits in the motor, and from the working pressure, we get at normal load for the apparent watts the value

3 (70 volts × 9.9 amp.)—2,079 watts.

The actual consumption, as the curve shows, amounted to 1,830 watts, and the fraction of the apparent value is .88. The difference in phase between current and electromotive force which, when running light, amounts to 72 deg.; at two horse-power load is 28 deg., and at three horse-power 22 deg. Whether this proportion appears as favorable in larger motors cannot be definitely asserted, the necessary measurements not having been taken.

The chief aim of the present article has been to draw attention to the rotary current as a new means of transmitting power, and to give a general idea of the system; many points will, therefore, seem to want further explanation, and the author intends to publish a series of independent articles on the details. He also hopes that the Lauffen-Frankfort installation will afford a large number of electricians the opportunity of inspecting the system at work.

Progress in the South.

The Alabama Polytechnic Institute, at Auburn, Ala., has recently organized a course in electrical engineering and is now engaged in equipping an electrical laboratory. Dynamos, motors, accumulators, measuring instruments, etc., are being rapidly set up. The authorities intend to make this the foremost school in electrical engineering in the South. They request manufacturers of electrical apparatus to send the Institute catalogues with discounts to colleges.

MR. GEO. W. LA RUE, GENERAL MANAGER CROCKER-WHEELER ELECTRIC MOTOR COMPANY, NEW YORK.

NEWSPAPER ADVERTISING.

NINTH OF A SERIES OF ARTICLES ON THIS IMPORTANT BRANCH.

The ninth in our series of advertising articles is written by Mr. George W. La Rue, general manager of the Crocker-Wheeler Electric Motor Company, of this city. This company is one of the progressive motor manufacturers, and is controlled by men of keen business acumen. Mr. La Rue's article will be found interesting.

TO THE EDITOR OF ELECTRICAL REVIEW:

It appears to me that the natural bent of the business man's mind is to let the community know what he is manufacturing, and to furnish the public with its merits and advantages, and, possibly, state at what price it can be obtained. The newspaper press, and particularly the trade journal that reaches a class of people that the manufacturer desires to sell his goods to, is decidedly the best medium. A great many people don't know what they want in this world until they see it advertised; other people know what they want but don't know where to get it. Advertising tells them. My wife is perfectly contented with her outfit until she takes up an evening paper and finds that Lord & Taylor have a fine line of silks on the bargain counter; immediately she needs a new garment, and my bank account goes down accordingly. In olden times when a man's horse or cow went astray, or he desired to exchange one of his productions for some other person's, or, perchance, wanted to dispose of his household wares to the highest bidder, he prepared a carefully worded advertisement to suit the emergency, and tacked or pasted it up in the most prominent place in the town or hamlet, where the most people could see it. Newspapers of a more enlightened age have taken the place of barn doors and roadside trees, and the party who has anything worthy of sale nowadays uses the trade journal or daily press. Some people have such an exalted idea of the merits of their wares that they think the public cannot do without them and that the fame of the goods will actually spread amongst the people, and thus they will be deprived of the necessity or privilege of paying advertising bills. This may be so in a measure, but give me a well conducted, active and energetic paper—like the ELECTRICAL REVIEW, which reaches thousands of people every week who want to buy the most perfect electric motor ever introduced to the world (excuse my modesty)—for my way of getting at the trade. It is my experience that advertising not only introduces my goods to the public, but actually popularizes them with the trade. The people like an enterprising manufacturer that so firmly believes in the value of his product that he challenges the whole world to know that he makes them. They believe that he makes honest goods and know that he is not afraid to go before the people on their merits. Judicious advertising, to my mind, will help any line of business that is honestly conducted, and it is well known to be the only salvation of humbug. I find that the notoriety and popularity that advertising gives to the Crocker-Wheeler motor, largely decreases the labor of our travelers on the road. If they find those whom they seek to trade with well informed as to the merits of our goods, from the illustrated articles (a new feature of advertising), more than half the work is done. I heard a "Missionary" (that is a traveling man) once say that he would not go on the road for a firm that didn't advertise, for it took too much valuable time to explain to every supposed buyer who he was, where he came from, and what the merits of his goods were. He said, moreover, that if the buyer had all this information beforehand he generally received him cordially, was glad to see him, and had been looking for him for some time. Although my experience in advertising does not extend over many years, I believe it is best to use largely the representative papers of the industries that you desire to introduce your goods to, or who would naturally buy them. These papers should be used carefully; prominent positions on the front page or next to reading matter, are worth many times more than ordinary advertising positions, and frequently one gets it at about the same price. I believe in an occasional illustrated article to educate the consumer of my wares and show him the advantages that my goods possess over those of other manufacturers of like goods. A bright trade note (another feature of advertising) is a valuable adjunct to the advertising department, for it keeps the people in mind of our establishment, demonstrates that we are continually making important improvements in our goods, and that people over the whole world are buying them. While I recognize the value and necessity of catalogues, circulars and attractive business cards, yet I am satisfied that the well conducted, progressive and alert trade journal, with a *bona fide* subscription list, is the shortest road to success in the present day and generation, and those who do not recognize this will be apt to be found far in the rear of the great business race of the age. I don't know that I have added anything to the fund of information on this important subject of advertising that your previous contributors have so ably and delightfully portrayed, but I thank you for your kind invitation to have "my say" on what I consider an important commercial duty, and which must be my apology for appearing in public print.

Yours very truly,

Geo. W. La Rue

New York, September 12.

Hart Switches.

The Hart double pole switch, which has just been put upon the market by the Hart & Hegeman Manufacturing Company, of Hartford, Conn., possesses all the merits of the Hart single pole switches, viz., durable construction, quick rotary movement in one direction, positive action, the switch plates being locked in position until they are under the control of the actuating spring, large contact surfaces and unusually long break for diameter of switch. The length of break in the 15 ampere double-pole switch, illustrated on page 50, is three inches, the outside diameter of brass being two and seven-eighths inches. The length of break increases with size of switch until, in the 100 ampere switch, it is six and one half inches. The 100 ampere double pole switch is mounted on a slate base six inches square, provided with clamping devices or binding posts, which will take wire up to 0000 B. & S. or flat bar up to three-eighths by three-quarter inches, and so arranged that the wire or bar may be brought down the face of switchboard or enter clamps from back of board, without bending it in either case. This feature facilitates neat and rapid construction. The long break and quick action of the double pole switches of all sizes, allow them to be used on railway or power circuits of 500 volts and on primary alternating circuits of 1,000 volts.

Street Railway Association of New York.

This Association met Tuesday of this week at the Hotel Metropole, New York city. An interesting paper on "Electric Motive Power for Street Surface Railways" was read by John N. Beckley, of Rochester. A full report of the meeting will appear in our next issue.

KINDRED INTERESTS

Ball Engine Company, Erie, Pa.—The Hotel Savoy, Fifty-ninth street and Fifth avenue, New York city, have purchased for their electric light plant three 100 horse-power and one 60 horse-power engines, through E. T. Copeland & Company, 106 Liberty street, New York. The Johnson Company, Johnstown, Pa., have just installed a 300 horse-power cross compound engine for their electric welding plant. The Tuscarawas Electric Company, Canal Dover, Ohio, has ordered a 100 horse-power engine.

Genuine Porcelain.—Perhaps some of us are not aware that porcelain is a product that can be counterfeited. We have been informed by the Empire China Works, of Greenpoint, Brooklyn, who are manufacturers of the genuine porcelain, that there are made imitations of porcelain which are being sold for the genuine article. It was once supposed that anything made of clay was porcelain, but there is now manufactured a substance containing much of alloy which is palmed off as the true product. The reliable company above referred to makes a specialty of producing the genuine porcelain, and it is unnecessary to say anything about the merits of this article as applied to electrical purposes.

Improved Portable Testing Set.

Something over a year and a half ago Messrs. Queen & Company, Philadelphia, brought out their now well-known series of portable testing and resistance sets, which have been used very largely for all classes of resistance work throughout the country; extensive experience with these sets seems to have developed very few possibilities of improvement. Almost the only feature which has been suggested as capable of improvement for use under certain conditions has been the galvanometer forming a part of these sets. As heretofore made, this galvanometer has been of the astatic type, fibre suspended, and arranged to automatically take the weight of the needle from the fibre when the lid of case was closed. A control magnet enabled the needle to be still more astatic. The sensibility of this galvanometer was very great, and it has been found possible to make very accurate determinations of resistance by its use, together with the set. Its astaticism, however, rendered it very susceptible to magnetic disturbances and mechanical vibrations.

With a view to doing away with this susceptibility, without detracting from the efficiency of the set, the makers have been devoting considerable attention to the designing of a new galvanometer for use with their sets. The galvanometer finally devised and shown on page 51 as part of the set is of the D'Arsonval type, very dead beat in its action, and remaining almost absolutely steady during all mechanical and magnetic disturbances. The set fitted with this new galvanometer may be used in factories where there is great mechanical vibration or in central stations, and in the vicinity of dynamo machinery where the magnetic field is very intense. In some recent tests this set was placed upon one large running dynamo while used to measure the insulation and resistance of another dynamo not running. In some other tests of the set it was placed upon a table and measurements made while the table was violently shaken. In both of the preceding tests measurements were easily and quickly made within an accuracy of one-fifth of one per cent.

The set with new galvanometer is particularly adapted for use in marine work, as the pitch and roll of the vessel will not appreciably affect the stability of the needle.

This new galvanometer is, like the astatic form, removable from the set, and may be used separately for any kind of work desired. This galvanometer cannot, of course, be made quite as sensitive as the astatic form; it is, however, sensitive enough for all but work of the very highest accuracy. To accommodate those doing the most accurate work the set will still be sold with the astatic galvanometer, which latter has also been improved by making the control magnet larger and completely removable from the galvanometer if desired. When the control magnet is to be used, it is removed from its fitting in the lid of the instrument, and can be instantly slipped into position over the galvanometer by means of a pair of spring catches. This galvanometer has also been so modified that it is practically impossible to break the glass covering the dial, a mishap sometimes occurring with the old type.

New Brush Apparatus.

For some years electricians have been working on the line of apparatus for power transmission. The Brush Electric Company have had this matter in mind for a long time but have not been fully satisfied with the results obtained until Mr. S. H. Short, now their chief electrician, submitted designs for the apparatus illustrated herewith.

The generator shown is capable of furnishing 100 horse-power at its pulley. It is of the closed coil armature type. The core of the armature is made up of thin sheet iron wound on a foundation ring and firmly riveted. The edges of this ring are then milled out slightly so as to allow for the bobbins of wire. The wires leading from the armature to the commutator are carried along the shaft and are very carefully and thoroughly covered, so as to protect them from dirt or damage of any kind. The bearing on the commutator side of the dynamo is placed outside of the commutator so as to allow a clear way for the connections between armature and commutator. These generators are very compactly built and the ventilation obtained is practically perfect. Any part of the machine can be inspected without disarranging other parts, and in case of accident the armature or magnets can be removed quickly and repaired with little trouble. Any one of the armature bobbins can easily be rewound without disturbing the remaining bobbins.

The construction of the motor is very similar to that of the generator. There is but one point to which we would call special attention and that is the fact that the motor requires no outside governor of any kind. It is so built as to take care of its own regulation. These machines are illustrated on pages 48 and 49.

The Brush Company say that they feel that they now have the best apparatus for transmission of electric power that has ever been designed. The generators and motors will be wound for an electromotive force of 1,000 volts, thus allowing the carrying of power over a considerable distance by means of a comparatively small wire. The new type of commutator with which both motor and generator are fitted runs with practically no spark, so that there is no trouble at that usually troublesome point.

BINDER FOR REVIEW

Will be sent to any address, postage prepaid, on receipt of 30 cents.

ELECTRICAL REVIEW,
13 PARK ROW, NEW YORK.

THE LAW
Double Cylinder Battery.

Surface of negative element and quantity of solution double that found in any other open circuit cell.

Weigh carefully these advantages.

Its sale has steadily increased for ten years.

LAW TELEPHONE CO.,
Sole Makers,
87 JOHN STREET, NEW YORK.

HJALMAR LOFGUIST,
Electrical Engineer, Stockholm, Sweden.
Office for Import and Export of Electrical Appliances. Best medium for introducing news in Electric Light, Power and Heating.

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Engine Lathes, 10 in. x 4 ft.; 11 in. x 5 ft.; 12 in. x 6 ft.; 14 in. x 6 ft.; 16 in. x 6 ft.; 18 in. x 8 ft.; 20 in. x 8 ft., with tapes attachment; 22 in. x 12 ft. and 14 ft.; 24 in. and 26 in. x 16 ft.; 30 in. x 10 ft. and 18 ft.; 36 in. and 38 in. x 30 ft.; 42 in. x 12 ft.; 56 in. x 18 ft.; 72 in. x 20 ft.; 108 in. x 22 ft. Fox Lathes, 13 in. x 5 ft.; 14 in. x 5 ft.; 15 in. x 6 ft.; 18 in. x 6 ft. Turret Lathes, 12 in. x 5 ft.; 14 in. x 5 ft.; 15 in. and 16 in. x 6 ft.; 18 in. x 6 ft.; 36 in. x 8 ft.
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ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON SEPTEMBER 8, 1891.

458,977 Safety device for electric elevators; Norton P. Otis and Rudolph C. Smith, Yonkers, N. Y., assignors, by mesne assignments, to the National Company, of Illinois.

458,987 Electric arc lamp; William A. Turbayne, Toronto, Can.

459,013 Telegraphic transmitting apparatus; Morris Martin, Malden, Mass., assignor, by direct and mesne assignments, to the United States Electric Fire Signal Co., of Maine.

459,024 Mounting for motors of electric cars; Sidney H. Short, Cleveland, Ohio, assignor to the Short Electric Railway Co., same place.

459,062 Coin-freed dynamometer; Charles A. Barrett and Alfred Barrett, London, England.

459,070 Electrically-heated wristband ironer; Willis Mitchell, Malden, Mass., assignor to the Butterfield-Mitchell Electric Heating Co.

459,088 Electric light fixture; Edwin T. Greenfield, New York, N. Y.

459,100 Incandescent electric lamp; Edward P. Roberts, Cleveland, Ohio, assignor to the Swan Lamp Manufacturing Co., same place.

459,127 Electrode for chairs; George W. Overall, Memphis, Tenn.

459,143 Electro-therapeutic truss. 459,144 Electro-therapeutic belt; Hugh W. Matthews, Chicago, Ill.

459,168 Support for electric conductors; George H. Winslow, Pittsburgh, Pa.

459,189 Controlling device for motors; Rudolph C. Smith, Yonkers, N. Y., assignor, by mesne assignments, to the National Co., of Illinois.

459,205 Telephone receiver. 459,213 Hook or crotch for telephone receivers; James H. Howard, Medford, Mass.

459,219 Electric switch; Lewis D. Castor, Philadelphia, Pa., assignor to William H. Weston & Co., same place.

459,222 Electrically operated brush; Frederick A. Lehmann, Washington, D. C.

459,229 Electric elevator; Harry H. Blades, Detroit, Mich.

459,266 Hanger for incandescent lamps; Paul J. Chassagne, Akron, Ohio.

459,321 Fuse and detonator; Paul Ward and Edward M. Gregory, London, England.

459,323 Electric contact apparatus; Christian Wenste, Duisburg, Germany.

459,306 Armature for dynamo electric machines or motors; Robert Lundell, Brooklyn, assignor of one-half to Edward H. Johnson, New York, N. Y.

459,367 Commutator brush and holder. 459,368 Commutator cylinder and method of making the same; Robert Lundell, New York, N. Y., assignor of one-half to Edward H. Johnson, same place.

459,370 Electric conductor; Edwin D. McCracken, Alpine, N. J., assignor to the Norwich Insulated Wire Co., New York, N. Y.

459,385 Flexible electric conductor; Hosea W. Libbey, Boston, Mass.

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ELECTRIC LIGHT CONVENTION SUPPLEMENT

TO THE

ELECTRICAL REVIEW,

SEPTEMBER 19, 1891.

PAPERS READ AT MONTREAL MEETING OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

A Central Station Combining the Advantages of both the Continuous and Alternating Current Systems.

BY H. WARD LEONARD, NEW YORK CITY.

We are all well aware of the fact that the greatest strength of the three-wire system is due to features, the lack of which constitutes the greatest weakness of the alternating system, and that the reverse of this statement is equally as true.

The high efficiency, reliability, safety and adaptability to supply almost any requirements for electric energy, which are the features of strength of the three-wire system, are the very points upon which the alternating system suffers by comparison, for its efficiency is much lower, its reliability is less due to the fact that its machines are not practically operated in multiple arc, its safety is necessarily less due to the existence of the high primary pressure, and its current is not adaptable to commercial use for motors, charging storage batteries, electro deposition, and so forth.

On the other hand, the low first cost of an alternating system, the simplicity of its circuits and of the operation of the central station and its ability to reach, with moderate expenditure of capital, lighting at any practical distance, make it the only possible pioneer in new and untried territory without great risk and almost the certainty of expending capital which will never be remunerative.

Hence, it is that we find the three-wire system in possession of the densely settled centers of cities and towns, and not extending to the outskirts, because of the uncertainty of a sufficient return upon the necessary capital, and both the central station manager and the distant would-be consumers anxiously awaiting the development of improvements which will enable the three-wire central station to supply such distant consumers. And hence it is that the manager and consumers of an alternating system anxiously await the day when motors can be operated and a more economical, safe and reliable current than the present alternating current can be furnished by such a station to supply the imperative wants of the heart of a busy city.

If the above statement of the present existing conditions be a fair one, it will be evident that if we could only in some way secure the advantages of both systems in a common distribution, we should greatly improve matters. The object of this paper is to point out what appears to the writer to be a step forward in that direction.

The following conditions seem to be necessary:

1. We must supply a continuous current for the central portion of a town during the daytime when power is required.

2. We must supply the outlying districts with an alternating current during the nighttime when lighting is required.

3. We must not operate the alternating system under conditions of light load when its efficiency is very low.

4. We must be able to supply current for lighting continuously throughout the 24 hours of the day.

5. We must have but one set of conductors in any consumer's place.

In order to meet the above conditions I propose the following:

1. Wire all consumers upon the standard three-wire systems.

2. Connect all consumers upon standard three-wire mains.

3. Arrange the network of mains so that the central section of the net-work can be disconnected from the outlying sections through the agency of switches.

4. Install three-wire feeders to supply the central portion of the systems at full load, and install 1,000 volt primary wires and alternating current converters with a three-wire secondary circuit to supply the outlying section at full load.

Let us see how we will operate the station. Suppose it is eight o'clock in the evening. The switches which serve to connect the central and outlying sections are open, and our three-wire plant is supplying the full load of the central portion of the city. The alternating plant in the same central station is supplying the converters of the outlying section, which convert from 1,000 volts primary to 220 volts in the secondary, and the secondary coil has a connection at the center which is led off to supply the central wire of the three-wire system of the outlying section, the outside terminals of the secondary being connected to the outside wires of the three-wire system. It will be noticed that both plants are being operated at full load.

Now, suppose it to be eleven o'clock. The load has gone off rapidly so that the alternating plant is now operating under the worst possible conditions, and these conditions will continue for the outlying district until dusk the next day—that is, for probably 18 hours. An operator is now sent out who goes to each section supplied by a converter, and by throwing a switch transfers the secondary wiring from the alternating system to the three-wire mains. In this way the small remaining load is gradually transferred to the three-wire plant and then the alternating plant is shut down. The three-wire plant continues in operation all night and all the next day, supplying all devices with a continuous current. Motors can be operated in all portions of the system, even for domestic purposes in the distant residences, and all consumers get the opportunity of the use of the continuous current for any purpose desired for 18 hours out of the 24.

Dusk now arrives and soon the heavy lighting load will rapidly come on, and in such case the outlying section could not be supplied by the small wires feeding the distant three-wire section during the day, which are only about one-tenth the size which would be necessary to supply the full load.

The operator again goes round the circuit and now transfers the load of the outlying section from the three-wire plant to the alternating plant, and this condition prevails again until 11 o'clock arrives, when the operation is repeated, as before described.

The switches for transferring the load of the outlying section from one system to the other can readily be controlled by simple means from the central station itself, if desired.

Now, let us look at some of the advantages we have gained.

All of our inside wiring is done on the three-wire systems for use of a lamp of 110 volts. This means that for the same distances and loss in conductors, we will save eleven-twelfths of the cost of copper which would be required by a secondary using 55 volt lamps upon a two-wire system; or, to put it another way, we can supply 110 volt lamps upon a three-wire system with the same cost of copper, and the same percentage of loss in conductors at three and a half times the distance which would be permissible for 55 volt lamps on a two-wire circuit.

We all know the great desirability of using large converters, on account of their cheaper first cost per lamp and their higher efficiency, and also because a far more perfect regulation of pressure can be obtained upon a lot of lamps scattered in different kinds of stores throughout a block, if they be supplied from one converter, than can ever be obtained by supplying these lamps by a lot of small converters loaded differently in almost every case, and consequently supplying a different pressure at the secondary terminals of each converter.

Under the system proposed by me one converter would ordinarily supply the entire lighting of a block, resulting in less first cost, higher efficiency of conversion, longer life of lamps, greater reliability and greater simplicity of plant.

A point worthy of notice is that for 18 hours out of the 24 an absolutely safe pressure is in use throughout the entire system, and that during all daylight hours, when the greatest liability to accident from contact with high pressure wires exists, no high pressure is in use.

With such a system no consumer need be turned away.

The consumer who wants to charge storage batteries, and also make welds by electricity, can do so upon the same day and from the same wires that supply his incandescent lamps.

The factory upon the outskirts of town, which runs its isolated plant, and must to-day either use storage batteries or run machinery all night to supply a few watchmen's lights, can now switch onto the central station at six o'clock, and operate the few lamps it may need until dusk next day, when heretofore the alternating system, which was the only one which could reach it, did not run after midnight, or possibly after daybreak, because of the loss of money in so doing.

With this system the outlying districts can be pioneered with the least first cost and least risk. Any outlying section in which, for any cause, the demand increases greatly beyond that originally anticipated, can be supplied permanently by the three-wire system by merely running the necessary feeders to supply the already existing mains, and in such case the switches and converters would be moved out further or transferred to some new section ready for pioneer work.

The combination of a storage battery system and an alternating system also presents peculiar advantages. The storage battery is at its best when supplying a small steady load, such as we have for at least 16 hours out of the 24. The alternating is at its best when supplying the full load possible only during the remaining eight hours. The average electrical load on a general system is only about 12 per cent. of the maximum, consequently, we are entirely safe in the statement that the greatest load during the 16 hours of light load is not more than 10 per cent. of the maximum load for the 24 hours.

If we were to attempt to operate the heavy load by storage batteries, we must either make an enormous investment, or, what is even worse, operate storage batteries at a disastrous overload. On the other hand, if we try to operate the 16 hours light load with converters, our efficiency, when operating at 10 per cent. of our converter capacity, would be unmentionably low. But reverse the case and everything works at its maximum efficiency. During the eight hours of possible heavy load we operate all devices by the alternating system. At the same time a continuous current dynamo charges our storage batteries located either in the central station, or, if more desirable, at different centers in the system of distribution. At the end of the eight hours' run we shut down the plant, lock up the station, and leave it for 16 hours, the storage batteries meantime supplying all devices.

If, for extraordinary reasons, we have not capacity sufficient in the storage batteries to supply the demand, we run the continuous current plant to assist it; and if that should fail or prove insufficient, we start up our alternating and supply all or a disconnected part of the system with it.

With this plant distances are of no consequence; we can use 1,000 volts for the continuous current plant as well as for the alternating, and the single two wire distribution is all that is necessary for perfect results.

The weak spots of this latter arrangement will, no doubt, be thought to be the storage battery, but my experience with this device is that if you use it properly under suitable conditions, and do not attempt to squeeze impossible results out of it, economical and satisfactory service can be obtained from it, and certainly no better conditions could be obtained for it than those described above.

Up to this time a bitter fight has waged between those believing that the alternating, the direct, or the storage battery system, respectively, was the only suitable one.

I believe in them all, each operated so as to be used under the best conditions for its use, and I trust that the suggestions given above may lead to our being better able to meet and overcome our common enemies: high first cost, low efficiency, danger, unreliability and the inflexible conditions of the existing demand.

Electric Railroad Construction and Operation, and a Consideration of their Connection with Central Station Interests.

BY C. J. FIELD, OF THE FIELD ENGINEERING COMPANY, NEW YORK.

INTRODUCTION.

The advantages of the electric railway have passed beyond the age of experiment or question. They are proved by their development in the past four years, and any argument as to their advantage in the general development of street railway practice or suburban rapid transit is antedated. It took several years to convince old staid financiers and directors of the larger street railway properties that it was to their finan-

cial advantage to throw in the scrap heap several million dollars, more or less, in equipment and spend that amount in addition and still make it pay; but they have seen this advantage in the development and increase of traffic and returns to their company. These returns have been brought about principally by the development of rapid transit, in the introduction of electricity and the flexibility of the system in adapting itself to all and any conditions of commercial practice.

In looking over the past four years of practice in electric railway work, we have much to commend and considerable to condemn. The boldness of the achievements, the problems that have been solved, the rapidity of development and the perfection of the apparatus, seem almost beyond comprehension. That this apparatus, in less than four years, should reach the high state of perfection, economy and efficiency that it has, as compared to the long years of development of other mechanical appliances, is remarkable. The natural consequence of this large amount of work and development in this short time is that there has been much work done that had better been left undone in the way of poor engineering, cheap work, and not a proper appreciation of the problem to be solved. These, in some few instances, have retarded the development and progress of electric railway work in their vicinity, but street railway companies have now come to a proper appreciation of the necessity of good work well done and that the wisest and best method is to consider carefully what will bring the best return for the money invested—not necessarily on the blind basis of the highest cost being the cheapest, for money can be wasted in this way as well as others. We have examples now in several directions of large equipments being installed on a sound engineering basis and with careful consideration of the best interests of the electrical interests, street railway owners and public combined, and we can safely add that there is no problem in this line which cannot to-day be taken up with a full assurance of practical solution and successful development in electric railway traction.

The future outlook of electricity in the development of rapid transit, inter-suburban, and even express service, is assured. We are coming now to the solving of the larger problems in this work and bringing the public to a proper appreciation of the resources and possible achievements in this line and its superiority over the old fogy systems of the past. We even see a considerable number of our friends from cable engineering lines of street railroad work coming over into the electrical fold, fully appreciating that the cable system has a very limited field for successful development and that electric traction is very broad gauge in the field of engineering work. Therefore, with this outlook, better construction work, better engineering, better mechanics, the solving of these larger problems are assured, and we see, even to-day, in a number of cases, electric suburban traffic supplanting steam on a cheaper, better and more successful basis. The favorable report of the New York Rapid Transit Commissioners has done much to add to public confidence in this direction. Electric manufacturing companies are assisting the development of the work by making their apparatus more substantial, better in construction and more satisfactory in its mechanical design and operation. The reduction in the speed of the motors, the development of single reduction and even of direct connected motors, is doing much to add to the confidence in this line.

We hear asked sometimes, by laymen, the question: "What speed can electricity obtain in railway work?" The able consideration of this subject in several papers, and practical experiments as well, enables us to reply, very briefly, but confidently, to this inquiry, that speed and power in electric railway traction are only limited by road-bed construction; in other words, any speed is obtainable within the range of possibility, with the maintenance of proper track. We do not intend, however, to generally review electric railway work, but more particularly to give some details of the practical problems in their construction and operation, and, therefore, we will leave the consideration of other parts of the subject to papers which will, no doubt, treat it more fully.

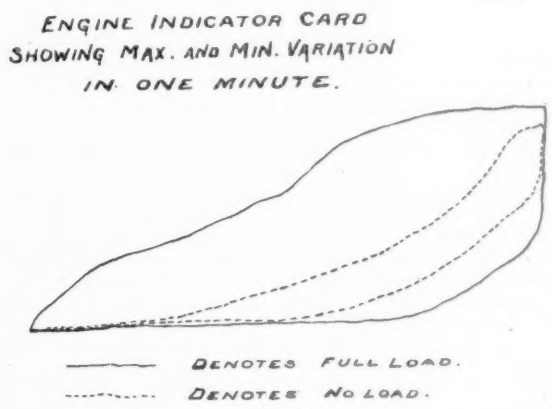

FIG. 1.

STEAM PLANT.

The consideration of the best development in the power generation of electric railway work has been one that has received considerable attention in past years from the best engineers in this line. We reach here a part of the problem which requires much more careful consideration than has been given steam power in electric lighting generally in the past. The work to be successfully done by the steam engine in the generation of electricity for the operation of railroads is the severest kind, and can be compared only to that of the engine operating rolling mill trains. It is owing to not fully appreciating this fact that we hear in some parts of the country of failures of steam plant on this kind of work. Electrical manufacturers are assisting the solution of this problem by the building of larger generators in units of 200 to 400 or 500 horse-power. What we want in the generating station for electricity is the smallest division of units consistent with the safe and economical operation of the station. Following the problem out on this line, we can build a successful station; and we would add to this that each unit should be entirely independent and separate from all other units, thereby increasing the reliability. This cannot be obtained in a safe and economical way by the use of our old friend, the countershaft. Undoubtedly, the countershaft has been of much use in electric lighting service, and particularly in arc lighting, but in railway work, with large generators, we can see no excuse at the present time for its use. Generators should be belted direct to the engines, whether Corliss or high speed, or else coupled direct to the engine shaft. With a Corliss engine of 500 horse-power, operating at 80 or 90 turns, with a fly-wheel 18 to 20 feet in diameter, we can belt with belt centers of, say, 40 feet, 2 inches, generators of several different commercial types; this gives us advantages which we have heretofore had only in high speed engines with direct connection. The engines should, in any event, as heretofore stated, be extra heavily built for the work to be done, with ample fly-wheel capacity. On engines of this size and speed a fly-wheel capacity of approximately 60,000 lbs. is about right. On engines operating about 150 turns, say, 30,000 to 40,000 lbs.

While laying particular stress on the rapid and sudden changes of load, we do not know how to illustrate it more forcibly than in Figs. 1 and 2. Fig. 1 will show a practical case of changes in the indicator diagram within one minute, placed on the cylinder of an engine running on railway work, which shows a variation within that time of from full load to no load and back again several times. Fig. 2 illustrates a load diagram from an ordinary case which has not been particularly selected for its maximum and severe conditions. These impress on the mind more forcibly than words can the requirements of this work. High speed engines in the development of railway work have received in some cases a set-back, owing to the engine manufacturers not appreciating fully the conditions and necessity of the work undertaken. So-called high speed or automatic engines can be as successfully operated on this class of work as any other, if they are specially built for it. This means larger parts, bearings of more ample size and length and ample fly-wheel capacity. On a cross-compound engine of, say, 300 horse-power, there should be about six to eight tons in the fly-wheels, the bearings seven or eight inches in diameter and 15 or 18 inches in length. (Such a type of engine is being furnished by the manufacturers of the Ball engine.) In the case of engines built in this manner, there can be no fault found with their operation. A type of engine, which we believe is going to be largely used on this class of work, as well as lighting work, is one that will come in between the high speed engine and the Corliss and which will combine many of the advantages of both. Such an engine has been sought for by many engineers and has been attempted by a number of builders. To-day, however, we cannot find it on the commercial market. This engine, in units of 500 horse-power, would run at a rotative speed of about 140 or 150 revolutions and with a piston speed of about 650 to 700.

The question which has troubled most engine men in regard to the high speed engine, with a single valve covering this kind of practice, has been a question of valves and clearances. Beyond any question, when it comes to this size, we have got to come to the Corliss practice of double valve, thereby reducing the clearances and bringing it down to the extent of the Corliss practice. The writer's company is having built, for the electric railroad at Buffalo, two engines of this class, by the Lake Erie Engineering Works, which we believe will do much to develop this line of work, and, also, will be particularly adapted for coupling direct to the engine shaft. In Figs. 3 and 4 one of these engines is shown coupled to the generator. The trouble in this line has been to get electric manufacturing companies to take up the building of large multipolar generators adapted for direct coupling at a speed of from 100 to 200 revolutions. This problem was developed on a much smaller scale in this country, for marine plants, several years ago. We find that in Europe, where their work has been more special, that they have successfully developed this type of engine and generator, and beyond any question, it is going to be both for lighting work and for railway work the type of unit for central station practice in the future. It means, where the vertical engine is used, the installation of the steam and electric plant in the space formerly used for engines alone. This means reduction in the cost of building, operation and maintenance.

In concluding this part of our subject on steam generation, we trust that our experience in the past in lighting will show us the fallacy of poor steam engineering, and that we will build our stations for the future, and not have the problems before us that nine-tenths of the electric lighting stations have to-day, which mean, that in order to get down to commercial economy and competition, they have got to rebuild their whole outfit. We will merely append to the consideration of the steam plant part of our problem a few interesting figures and data which the writer collected for presenting to street railway companies, in order to give them some useful information in this respect. We believe that they may be well introduced here. The figures given on the tables, etc., are not ones that the manufacturer of an engine would tell you were those of the best economy for his engine or plant, but they are figures which will be

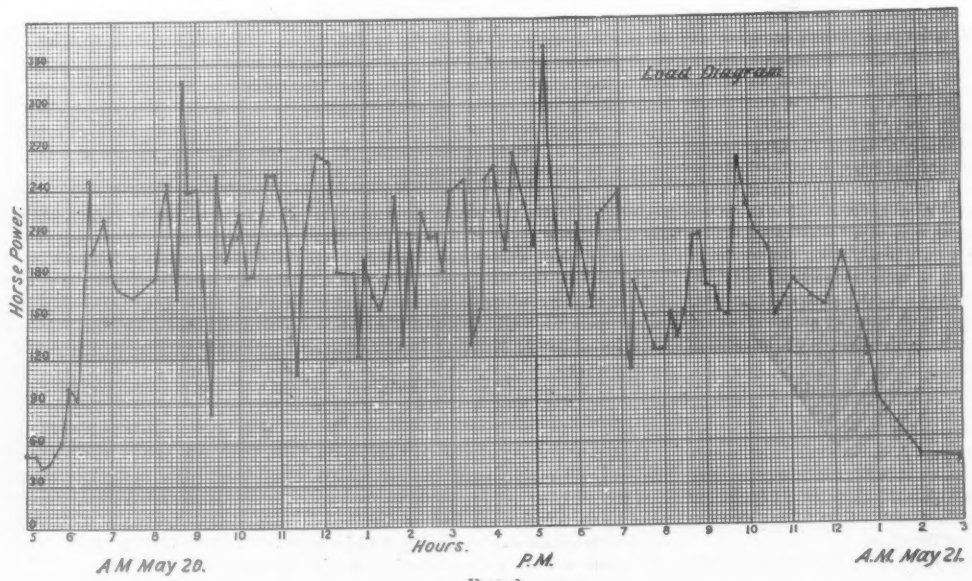

FIG. 2.

appreciated by station owners and railway companies as those which are obtained in every-day commercial tests.

The relative commercial economy of engines and cost are as follows:

TYPE.	LBS. OF COAL PER H. P. HOUR.	COST PER H. P. SIZES OVER 100 H. P.	
High speed single	4 to 5	$11 to $18	This is based on an evaporation of 9 lbs. of water per lb. of coal.
" " compound	3 to 3½	14 to 16	
" " " cond.	2½ to 2¾		
" " " triple	1¾ to 2	18 to 22	
Corliss single	3½ to 4	16 to 18	
" compound condensing	1¾ to 2	22 to 25	
Corliss triple	1½ to 1¾	27 to 30	

There are four classes of boilers:

1. Horizontal return tubular, which is the most general in use, and costs $9 to $10 per horse-power.

2. Vertical tubular (Corliss or Manning) which is a vertical tubular boiler with water leg, giving an internal fire-box, economical in floor space, largely used throughout New England. Cost $10 to $12 per horse-power.

3. Sectional or water tube boiler, of which Babcock & Wilcox is the best known, especially adapted for higher pressures and safety. Cost $17 to $19 per horse-power.

4. Scotch type of marine boiler—one that has not been used to any extent as yet in station work—but we believe it will be as an offset to the sectional type; and fulfilling the requirements for higher pressure and economy of space.

Capacity of engine requisite for different generators: (See table below.)

The cost of steam plant complete is about $50 to $60 per horse-power for high speed, and $65 to $75 per horse-power for Corliss.

ELECTRIC PLANT.

The question of the best electrical generating plant for railway work is one which is allied closely to that of steam plant, particularly in relation of the generators to that of the engines. In some respects, in treating of the steam plant, we have intimated what our idea was in connection with the generators. All large generators of from 200 to 500 horse-power connected as directly as possible, either by direct belting or shaft coupling, with the engines operating the same. It is only by this development that the safest and best solution of electric railway station practice—in fact, station practice in general—can be reached. Manufacturers of railway generators have had an experience extending back many years, that experience in the development of direct current incandescent machinery, although not of quite the same voltage, has led the way up to the safe, economical and commercial development of railway generators; and we find the railway generator of to-day one of the most perfect and reliable factors in the electric railway system. The only problem remaining to be solved in this connection is to build them in larger types and have slower speed for direct shaft coupling. Generators on this work are subjected to the severest and most excessive strain, particularly where of small type, but the building of them in larger units is going to remove, to a great extent, the question of the overloading of the machine. Railway machines are often subjected to an overload of from 25 to 50 per cent. In general these are only momentary, and we find most of them able to stand up to the work to be done.

The question which puzzles many of the railway companies, as well as the electric companies, is what amount of generating capacity is necessary for the operation of a given number of cars. This question, of course, has got to be carefully considered in connection with each case, but there can in a general way be laid down an approximate basis for this work. Some railway companies, in order to show a higher economy than their competitors, are unwisely claiming the requirement of a smaller amount of power than others; but the wisest manufacturer is the one who urges his client to install a larger amount of power than is barely required for the successful operation of the road under any and all conditions. For if any one thing will lead the public to condemn the electric railway traction it is a lack of power, thereby causing the cars to move slowly, and in case of any accident, disabling part of the power. A fair basis on general conditions for 16 to 18-foot car bodies is 20 to 25 horse-power per car, which, with a properly designed and constructed plant, will give the desired power. The cost of generating this power for railway work for 16 and 18-foot cars is three to five cents per car mile for all expenses of the generating station. In some roads we find that cars of a larger size than these do not necessarily take a proportionately larger amount of power. We find from practical experience that a car 32 or 33 feet long, double the size of the 16-foot car, takes, under general conditions, about 50 per cent more power, and we find by the same experience that a trail car adds about 50 per cent. to the amount of work to be done on the motor car for the same size. As to the minimum and maximum amount of power taken on an electric car, we find that a general average for a 16-foot car, under ordinary commercial conditions, without excessive grades, is one horse-power per car mile per hour; or, a car operating at an average 10 miles per hour means an average of 10 horse-power per car. This same car will give, however, on a load diagram, taking all its conditions, from maximum to minimum, a variation of from nothing to 50, 60 or even 80 horse-power. This gives us an idea of the severe strains and conditions to which an electric motor is subjected.

GENERATOR.	ENGINE.						
		HIGH SPEED.			CORLISS.		
WATTS.	HORSE-POWER.	Size.	Speed.	Wt. 2 Fly-Wheels.	Size.	Speed.	Wt. 2 Fly-Wheels.
50,000	75	12 x 12	280	7,000 lbs.			
80,000	125	15 x 16	225	9,000 "			
150,000	225	18½ x 18	200	15,000 "	20x36	90	25,000 lbs.
2,150,000	450				24x48	80	50,000 "

Steam pressure, 100 lbs.

FIG. 3.—CARS, POLES AND OVERHEAD CONSTRUCTION—BUFFALO RAILWAY.

FIG. 4.—INTERIOR OF POWER STATION—BUFFALO RAILWAY.

ELECTRIC CARS AND THEIR EQUIPMENT.

One of the questions on which we find more variety of opinion than any other is what is the best size, type and style of car for given case and conditions. The old standard 16-foot car body we find is now being widely departed from, and the problem is, How large a car can we get on a single truck with four wheels without excessive destructive effect on the road-bed? and, What is the longest car we can operate on street car service economically on an eight wheel base? We believe the limit is reached with a single truck in a 20-foot car body; we know that the truck manufacturers claim in some cases to operate a longer body, but we do not believe it wise. An 18 or 20-foot car running under close headway

we believe to fulfill best the conditions of city traffic in the larger cities. Such a car, with a wheel base of seven feet, and in some cases seven feet six inches, where curves are not too sharp, will give satisfaction, and not be too severe on the road-bed where the same is properly constructed. As to the difference in effect on the road-bed between the electric car and the horse car, it is briefly that the horse car is pulled by horses, from which it receives a balancing power and a steady pull, whereas, an electric car is operating itself by a power moving the wheels against the track, having no steadying or balancing power from the pull of the horses, and transmitting all its power and moving itself through the wheels. We find, therefore, that it subjects the track to a very severe pounding, necessitating a much better construction of road-bed, practically equaling that of a steam railroad.

Some companies have favored the use of a vestibule on street cars. We believe, though, that any vestibule is a failure and a misnomer. It accomplishes no good and causes much trouble; a shield over the dash-board for the motor man in winter weather would give all that would be required. What is wanted on a street car is that which will allow the freest ingress and egress from the car for the passengers, and anything that retards this—and a vestibule most certainly does—is a detriment and an obstacle to rapid transit. On some roads we have tried the introduction of even larger cars, say, 28-foot body, or 36 feet over all. Such a car, of course, has to be put on a double truck. These cars have found favor with some companies when first considering the problem; the difficulty with them is in getting the passengers in and out of the cars as quickly as possible, and making too many stops, due to the larger number of passengers carried. For inter-suburban heavy traffic, with few stops, we believe such a car would fulfill the requirements, but only in such a case.

Thus, having gone over the question of the cars, we come to the consideration of the electric equipment for the same. To-day we find the double reduction motor discarded, as far as any new equipments are concerned. All the large electric manufacturing companies are placing single reduction motors on the market, and they are in successful commercial operation. One company is placing on the field a motor directly connected to the shaft and without any gearing—in other words, there is no reduction in speed, the speed of the armature being the same as that of the wheels—the same is accomplished by a very ingenious arrangement. We have heard asked in the past the question, Why was it necessary to place 30 horse-power to operate an electric car to do the work that two horses had done formerly? The answer is: The two horses did not do the work in a proper manner and give rapid transit. The life of a street car horse is very short, and we find under general conditions that 30 horse-power with two 15 horse-power motors has been found about right; in fact, we even find the companies tending towards a larger installation of power, particularly when using larger than a 16-foot car body, and we find to-day, being installed for rapid transit in inter-suburban work, 40 and 50 horse-power electric equipments per car, many of them operating at a speed of 30, and even 40, miles per hour. As the amount of power is directly proportionate to the speed, we can readily see the requirement for such an amount of power. The cost of a single car equipped, including the car body, truck and motors, is from $3,000 to $3,500, and the cost of the electric part of the power generating plant is from $35 to $45 per horse-power.

LINE CONSTRUCTION.

We find in the past about as great a development in overhead and line construction for electric work as in any other part of the subject. While formerly this was one of the greatest sources of unreliability in the operation of the plant, to-day it has reached a very practical development. Formerly the trolley wires were too light, the feed wires were insufficient to furnish power, and the line was giving trouble, grounding and breaking continually. In the insulation of a single trolley system, with one side of the system grounded, we have the most severe requirements that it is possible to obtain in any electric insulation, in that any grounding on the other side of the system means trouble in the operation of the road. This has led to the introduction of double and even triple insulation into our line material to properly protect the trolley wire from grounding. Where streets are wide enough to spread the tracks to six feet and six feet six inches within the near rails we see introduced in many places center iron poles, which make a considerably stronger style of construction than cross-suspension. There are not many streets, however, where street cars are in operation that are wide enough, or where the city will allow the spreading of the tracks to this distance, and in closer proximity it is not safe to operate with center poles. On the work installed by the Field Engineering Company, in Buffalo, we find the most extensive system of overhead and underground construction in operation anywhere. Here all the feed wires, with a few exceptions, are placed in underground conduits, thus removing all cause for objection to the unsightliness of a large number of feed wires overhead. These underground feed wires are connected to the overhead wires from junction boxes up the poles. Thus, in Fig. 3 is shown one of the lines on the Buffalo Railway system, which gives an idea of this style of construction, as well as the use of the large cars, which are 36 feet over all.

The cost of overhead construction may be about summarized as follows:

Line construction per mile, complete, including track bonding, plain pole work, cross suspension or bracket with feed wire, $2,000 to $2,500; with sawed and painted, poles, $2,500 to $3,000; iron poles, cross suspension, concrete setting, double track, feed and guard wires, $6,500 to $7,500; same with center poles, $4,500 to $5,500.

We also append a table which will give a general summary of the cost of electric equipment of street railway systems, omitting the track construction, which, of course, varies with the number of miles to be equipped.

COST OF ELECTRIC EQUIPMENTS FOR STREET RAILROADS.

No. of Cars.	Steam Plant. H. P.	Capacity of Generators. K. W.	Steam Plant. †	Station Electrical Equipment.	Car Equipments. Car Trucks and Motors.	Line Construction ½ mile of Double Track per car.	Total Equipment (omitting track).
6	120	80	$7,000	$6,400	$19,500	$7,500	$40,400
10	225	150	11,000	10,500	32,500	12,500	66,500
15	375	240	17,500	15,000	48,750	30,000	111,250
20	450	300	22,000	17,500	65,000	40,000	144,500
30	675	450	28,000	23,000	97,500	90,000	237,500
50	1,125	750	50,000	33,000	162,500	187,500	433,000
100	2,025	1,350	90,000	60,000	325,000	375,000	850,000

The above figures are approximate only and based on the best City R. R. practice.
† Add 25 per cent. to these figures for Corliss.

TRACK.

The track of street railway companies before the introduction of electricity was more behind the times than any other part of their equipment. The old flat rail is antiquated and antedated, and in a few years its use will be obsolete. The necessities of electric railway traction—in fact, of any traction—have impressed upon the street railway companies in their equipments the requirement of a good road-bed for the successful operation of a road, and we find this part of the problem receiving as much attention as any with companies who appreciate fully the work before them. The general construction to-day is girder rails of from 60 to 80 lbs. per yard, placed on chairs where block paving is in use, with ties 2½ to 3 feet between centers. We find in some cases even 90 and 100 lb. rails used, but we believe in more moderate weight for the rails and the ties placed closer on centers. We believe this has been the general experience in railway work. Such a style of construction costs from $9,000 to $10,000 per mile. In suburban roads, on streets where there is no paving, we find the T rail being used; the road-bed can be properly constructed on this basis with 45 to 50 lb. rail, for $6,000 to $6,500 per mile, the rail being spiked directly to the ties.

In order to make a summary of the data and figures, I will summarize them in a practical example.

AN ILLUSTRATIVE EXAMPLE.

I propose to take, as the best means of illustrating practically, the purchase, equipment and operation of a street railway system with electricity, a city with a population of say 100,000—with a dilapidated street railway system, earning a gross income of $125,000, to purchase same for $500,000—property rights franchises, etc., and equip it with 40 miles of single track and 65 electric cars.

COST OF EQUIPMENT.

Steam Plant (1,500 horse-power steam plant):		
Five engines, 250 horse-power each, compound condensing, size 16 inches x 32 inches x 42 inches, with wheels weighing 30,000 lbs..	$32,500	
Eight R. T. boilers, 72 inches x 16 feet.....	9,600	
Jet condensers.	3,000	
Two boiler feed pumps.	900	
Steam and exhaust piping.....	12,000	
Five engine foundations.	3,500	
Eight boiler settings....	3,200	
Five 30-inch belts.....	2,000	
Erecting and starting...	3,500	
Freight and miscellaneous.....	2,500	
		$72,700
Electrical plant:		
Five generators, 200 kilowatts, 7,500.....	$37,500	
Switchboard installation, foundations, etc.....	4,000	
		41,500
Building:		
Power station, including stack, traveling crane, etc.....	$25,000	
Car house and repair shop, including tools, etc.....	15,000	
		40,000
Track construction:		
40 miles girder rail construction, ties 2½ feet centers, 63 lb. rail, etc., $1.15 per foot.....	$244,880	
Relaying, including paving, etc., at 60 cents per foot.....	126,720	
Trucking, hauling, etc.	24,000	
Ties, including 10 per cent. of joint ties, 130,000 at 40 cents....	52,000	
Ties, including 10 per cent. of joint ties, 15,000 at 70cents.....	10,500	
		456,100
Line construction:		
Ten miles iron poles, etc.	$75,000	
Ten miles wooden poles, etc.....	40,000	
		115,000
Car equipment:		
65 electrical equipments at $2,000.....	$130,000	
65 car bodies, 18-foot body, with open ends.	65,000	
65 trucks at $250.....	16,250	
		211,250
Summary:		
Steam plant.	$72,700	
Elect. plant..	41,500	
Building.....	40,000	
Track.....	456,100	
Line construction.....	115,000	
Car equipment.....	211,250	
		$936,550
Superintendent's and Engineer's work.. ...	$50,000	
General and miscellaneous.....	50,000	
		100,000
		$1,035,550
Original purchase.		500,000
Total cost re-equipped... ..		$1,535,550

Gross income, say, $350,000.

Net income, say, 35 per cent., equal to 8 per cent. on cost, on the basis of an investment of about one million and a half of dollars, and from a property which in many instances was hardly earning its fixed charges formerly.

We have here illustrated a practical example of what is being done every day in this country at the present time in the purchase and equipment of street railway systems. In fact, we find a large number of bankers and capitalists giving it their earnest attention as one of the best fields for investment at the present time.

CENTRAL STATION IN CONNECTION WITH ELECTRIC RAILWAY WORK.

We desire to call the attention of central station owners to the profit to be made from the furnishing of power in street railway operation, and also by the combining in smaller towns of the street railway companies and electric light companies. The trouble in most cases in central stations obtaining contracts for power, outside of small roads, has been to convince the railway companies that the electric light station can economically and reliably furnish this power, and we must say that in many cases their fears are well founded. Therefore, it behooves the central station companies to place their generating plants and station, not only for their own business, but for this added business, in such a shape as to remove this objection. There is no reason why electric light stations should not do a large and profitable business in this line as well as in stationary motor work, for the same factor is introduced here and the same reasons why they can safely and profitably furnish this power; if they have a station properly built, and large enough to add this power, that factor is established. If they have a proper station operating force, in many cases this force need not be added to at all. As to what basis this work can be profitably done on, we hesitate to state figures, except in specific cases, but will try to give a general idea of some of them. For many small roads power contracts have been taken at so much per day, assuming a basis of 100 to 125 miles operated. Such contracts have been at from $3 to $5 per car. The regular basis, in accordance with which most street railway companies make their contracts and desire to base their cost of operation, is the unit of car mile operated; therefore, most contracts are on this basis. This comes down, therefore, to a basis of from three to five cents per car mile; the latter figure we consider excessive, and one which would be only made by any company for temporary necessities. We know of cases where the matter has been carefully considered and the plant properly installed for it, where contracts have been made for between 2½ and 2¾ cents per car mile for 16-foot cars, on roads with grades not exceeding 1½ to 2 per cent. In this case, and, in fact, in most cases where the closer figures prevail, the railway company furnishes the generators and the station owner furnishes the steam power and all expenses of both steam and electric power due to ordinary wear and tear. A profitable source of investment has been found in the more moderate sized towns of, say, up to 30,000 or 40,000 inhabitants, in the installation of combined electric railway and lighting stations; the companies either equipping new ones or purchasing old street railway systems and dilapidated lighting plants running on an unproductive basis, but which have a good franchise and field for business. Such companies have proved very profitable, as the combining of the operating expenses for railway and lighting

station has done much to reduce expenses, and in many cases one manager or superintendent has proved sufficient for the entire system.

What we have tried to prepare here has been, not a paper which will be so attractive to merely read, but in which will be combined a certain amount of data information which will be of use in the further consideration of the problems herein outlined, and trusting that, if we have accomplished nothing else, we have led you to a profitable line of thought, it is respectfully submitted.

Central Stations Operated by Water Power.

BY GEO. A. REDMAN, SUPERINTENDENT BRUSH ELECTRIC LIGHT COMPANY, ROCHESTER, N. Y.

Mr. President and Gentlemen:

The purpose of my paper is more to give a description of what is being done with water power for electrical purposes in the city of Rochester by the three different electric light companies doing business in that city, and some of my own experience with water power, than to take up your valuable time with the technical description of turbines, which can be gleaned from any of the numerous catalogues of turbine manufacturers, which contain full descriptions of turbines and their construction.

The adaptation of water power for electrical purposes has grown very rapidly within the past few years; there are several causes operating to enhance the value of water power, none more so than that of electricity.

Streams that have had no pecuniary value heretofore are now being utilized for the purpose of running electrical machinery, yet at the same time the supply of water is diminishing, caused by the destruction of forests, and water right owners in various parts of the country are devising means of storing water during the rainy seasons to furnish a supply during the dry season; also storing it in the daytime for night use. One large water right owner in Western New York, during the months of July and August, places flash boards two and one-half feet high on top of his dam, at an expense of $100, and stores up for night use the water which is not necessary for him to use in the daytime, thereby saving in the two months a coal bill of $2,100.

The Johnstown, N. Y., Electric Light Company have improved their water power at the Cuyadota Falls by erecting a dam 34 feet high on top of the falls, giving them a total head of 75 feet and nearly doubling the amount of power.

A survey of the upper Genesee River, between Mount Morris, N. Y., and the celebrated Portage Falls, has been made during the past year for the purpose of establishing a reservoir that will furnish the city of Rochester 30,000 horse-power more daily during the entire year than they have at present.

The earliest forms of water wheels were the paddle and flatter wheels that only utilized the impulsive action of the water; these were followed by simpler wheels of the reaction type and others.

We now have the improved forms of the Leffel, Victor, Lesner, Success, and many others. There is a demand for the best and most economical turbine that can be manufactured.

Turbines should be built to secure the delivery of the water upon the turbine without checking the velocity of the water more than one-third, and permit the free discharge of same after passing through the turbine, and to work with as good efficiency under part gate as under full gate, and to be made of the best phosphor bronze, to stand the wear and tear under high heads.

It is essential in locating central stations to be run by water power, to locate them where there is no great danger of a flood, or so protected by a breakwater as to make it perfectly safe, and also to avoid trouble with backwater upon the turbines.

Where a station is situated on the bank of a river it is best to take the water from the river by means of a raceway, with the headgates parallel with the flow of the water, and at times of a freshet or running of anchor ice, it will more than pay any expense incurred by so doing.

The raceway should be of a sufficient depth and width to permit the water to flow not more than 90 feet per minute, and a waste gate should be placed in the side or end of the race to use in case of emergency; and when cleaning out the raceway a rack should be built across the race to prevent driftwood and other rubbish from passing into the turbines.

For that purpose I would recommend a rack built of iron slats two inches wide, one eighth of an inch thick, and placed five-eighths of an inch apart on seven-eighth inch iron rods, at an angle of 45 degrees. Particular attention should be taken to keep the rack clean by raking. A trough or platform should be placed over and immediately back of the rack to rake the rubbish and anchor ice into, and so arranged that a current of water from the race will pass through the trough and carry off all of the rubbish, etc. For any station that is using 100 horse-power or over, it will be a great saving in labor to them and pay well for the extra expense. For winter service a boom should be placed in front of the headgates, and the current will carry off a large portion of the anchor ice and other floating objects.

The headgates should be built to work with a rack and pinion; also a roller should be placed back of each gate stem to facilitate the handling of the gate.

The gates should have a protection built over them, to protect the gearing from the storm. In a cold climate, where the gates are apt to be frozen in, salt is essential in freeing them from ice, all headgates and timbers should be of the best quality of oak, and should be well bolted, and not less than two gates to one raceway. The tail race should have not less than two to three feet of dead water when the wheels are not in motion.

Where the tail race runs under the station, cement floors should be laid to prevent moisture in the station; a floor of that material will soon pay for itself.

Vertical turbines should be placed so that the steps are covered with water at all times. In adapting turbines to very high heads, or to conform to location, it becomes necessary to set the turbines above tail water, and conduct the water away from the turbines, through a draft tube; the same depth of pit and area of discharge is required where a draft tube is used, as would be when the turbines are set at the bottom of the fall; the mouth of the draft tube should always be submerged about six inches in standing tail water. It is claimed that draft tubes can be used 30 feet in length. I do not think a draft tube more than 18 feet in length should be used, on account of the difficulty in keeping the tube airtight, for if the tube leaks the vacuum is imperfect and there will be a great loss of power, and where steps are used they will be apt to be burned out.

When possible, I would advise horizontal turbines to be used, as they are easier taken care of, and many of them are used without any steps. The burning out of steps is an expense and annoyance. One of the greatest advantages in the horizontal turbine is that the dynamo can be belted direct to the turbine shafting, and is in some cases coupled direct to turbine, making a good percentage in economy in power and avoiding the use of gearing, and I deem it advisable to put in a number of small turbines, instead of one large one; in case of a break-down, they are more easily repaired and cause less delay to customers.

In the old station of the Brush Electric Light Company, of Rochester, the vertical turbines caused considerable annoyance in the burning out of steps and stripping of the gears; so much so, that it became necessary to support the vertical shafting with water cushions. For wooden steps we have had the best success with lignum vitæ.

In my opinion, governors for the turbines are necessary and will govern any slight variation of load under high head, but where one-third or over of the load is thrown off or on suddenly, it is necessary to handle the gate by hand, as under the above circumstances the turbine is apt to slack down or run far above the normal speed, as the case may be; in the latter case causing the burning out of lamps and armatures. The governors should be placed as near the turbines as possible to save lost motion in the gate shafting and avoid the use of gearing as much as possible.

We have two governors in use in our office building under a low head of 16 feet, and they govern the turbines under all circumstances in quite a satisfactory manner.

The decided advantage of a water power station over one run by steam power, is not only one of economy in the saving of the expense of coal, but the station and apparatus can be kept cleaner and cooler, thereby saving considerable in expense of repairs, and it is also far more pleasant for the employés.

The Brush Electric Light Company, of Rochester, purchased the entire lower Falls of the Genesee River (which is about two miles from the business center of the city) some nine years ago, at that time it was looked upon by many as a piece of folly, to think of running dynamos there, on account of the distance from the business center of the city and the dampness around the Falls. Notwithstanding the adverse opinions, they erected two buildings on the west side of the river above and near the brink of the Falls, and put in two 30½ inch Leffel, two 20 inch Victors and one 40 inch Leffel turbine, the first four mentioned turbines, under 94 feet head, and the latter under 28 feet head, with a total of 2,500 horse-power. After running this power for five years they built a new station and leased their old power to different parties for pulp and flour mill purposes.

The new station is a three story stone building, 45 feet wide and 90 feet long, with a two story brick addition 42 feet wide and 80 feet long, and located at the foot of the Falls on the east side of the river. The turbine capacity consists of 15 double 15 inch horizontal Lesner turbines under 90 foot head, with 14 foot draft tubes, a total of 3,360 horse-power, using 6.95 cubic feet of water per minute per horse-power; have had but one turbine damaged to any extent in four years. The turbine casings are placed on iron girders with the ends of the girders resting on solid rock.

The amount of floor space occupied by all of the turbines is four feet by 38 feet; the weight of each turbine is 196 pounds, less than one pound to a horse-power; each turbine is placed in a separate division of the casings and the shaftings extend through the shafting room, upon iron bridge-trees, with seven feet and six inches between journals, and the dynamos are belted direct to the turbine shafting; the shafting runs at 800 revolutions per minute, with 25 inch pulleys on the turbine shafting and 24 inch on the dynamos; we use untried beef tallow for lubricating and are well satisfied with its results. The turbine gate shafts and governors are placed in the dynamo room at an average distance of 14 feet from the turbines, where they are easily handled by the attendants. A tell-tale is placed in the shafting room, connected to a float in the race above the Falls, which shows the height of water in the race at all times.

The water is taken into the raceway about 80 feet above the Falls; the race is 32 feet wide, and five feet six inches deep and cut through the solid rock; there are four headgates with a house built over them; a wooden diagonal rack is placed in the race near the spillway to assist in freeing the race from anchor ice; the spillway is six inches deep and 32 feet long. The waste gates are placed next to the spillway and are three feet six inches wide; there are two of them. In front of and near the top of the penstocks an iron rack is built according to dimensions given; also a rubbish trough.

There are three iron penstocks, six feet in diameter and 80 feet high, built of three-eighth inch boiler iron, with a gate to each penstock.

There are five elbows to each penstock, leading to as many turbines, with an iron slide gate to each elbow; in addition, each turbine has a register gate, thereby permitting the repairing of any one turbine without interfering with the running of the others. A turbine can be taken out and another put in its place in 25 minutes.

Cement floors are laid in the shafting and turbine rooms.

There are three tail races, extending under the entire length of the main building; each race is nine feet wide and six feet and six inches deep.

As a reserve power, when making repairs and cleaning the raceway, we have a 600 horse-power Cooper Corliss engine; in the past year it has been necessary to use it but a few days.

For fire protection, two-inch iron pipes are run from the penstocks through both buildings, with four lines of hose attached at all times; the hose is tested once a week; in addition to the hose, a dozen fire pails filled with water and placed in different parts of the station are kept in readiness, and are not permitted to be used for any other purpose.

A record is kept of the time of starting and stopping of each turbine, also the speed and load on same, and any variation in height of water, and all repairs that are made. In addition to the above records, the day and night wheelmen report the condition of the power at the time they are relieved.

There are nine men employed at the station, five of them in the dynamo department and four in the water power department.

We have in service 30 dynamos; three of them are run without any stoppage and the balance of them on an average of 13 hours per diem.

A record book is kept in the dynamo room, in which entries are made of the time of starting, stopping, speed and load of each dynamo, also all repairs of every description, all accidents to either machinery or circuits, nature, time and cause of same.

All the circuits are tested five times daily, and the tests and time of same entered in record book.

By the means of water power the company is enabled to furnish cheap and satisfactory light and power at the following rates, viz.:

City arc lights, all night and every night, 27 cents per night; Commercial arc lights, all night and every night, 40 cents per night; Commercial arc lights, evening, 25 cents per night; Commercial arc lights, evening and all day, 40 cents; ⅛ horse power motor, $18 per annum; ¼ horse-power motor, $48 per annum; 1 horse-power motor current, $72 per annum; 2, 4 and 6 horse-power motor current, $50 per annum, per horse-power; 8, 10 and 15 horse-power motor current, $40 per annum, per horse-power; ⅛ horse-power fan motors, $15 per season, from June 1 to October 1; 16 candle-power incandescent lamps, $5 to $12 per annum; 25 candle-power Bernstein lamps, $12 per annum; 50 candle-power Bernstein lamps, $24 per annum; 100 candle-power Bernstein lamps, $48 per annum.

The rates I have mentioned are for arc circuits; our rates for current on 500 volt constant potential circuits are as follows, viz.: 1 horse-power, $48 per annum; 2 horse-power, $96 per annum; 5 horse-power, $180 per annum; 8 horse-power, $240 per annum; 10 horse-power, $300 per annum; 15 horse-power, $450 per annum; 20 horse-power, $600 per annum.

We operate a total of 832 motors, of which 196 are fan motors, 1,396 arc, 135 Bernstein and 200 Swan incandescent lamps. One motor circuit contains 26 miles of outside wire and 394⅛ horse-power "C. & C.," one 2 horse-power and one 4 horse-power Brush motors, and is run with a No. 8 Brush arc dynamo. We have one 40 K. W. 500 volt "C. & C." generator in service, on an eight mile circuit, with 48 horse power in motors in use; the ammeter averages 29 amperes,

We experience no difficulty in running same with our power.

The rebate for poor service during the year ending December 31, 1890, was one one-hundredth of one per cent. of the gross receipts, and the uncollected accounts for the same period was one tenth of one per cent. of the gross receipts.

The Edison Electric Light Company have recently erected a three story stone station at the foot of the upper Genesee Falls, on the west side of the river, and have at present two double discharge Leffel mining wheels under about 90 feet head, giving 600 horse-power, and are placing two more of 400 horse-power each. In addition, they have a fine steam station in the center of the business district. Incandescent 16 candle-power lamps are furnished at one cent per lamp hour; arc lamps for city use, 28½ cents per night; municipal incandescents at six cents per night. The latter they are partially replacing with arc lamps. They have in circuit 105 arc, 805 municipal and about 13,500 16 candle-power incandescent lamps.

The Rochester Electric Light Company's plant is situated at the upper Genesee Falls, on the east side of the Genesee River, near the business center of the city.

The station is three stories in height from the top of the Falls, with the wheel-pit underneath, blasted out of solid rock 95 feet in depth. They have five Leffel horizontal turbines; four are 23 inches, and the other 30½ inches in diameter, with a total of 1,500 horse-power, under a head of 86 feet and eight inches.

The penstock is a steel pipe seven feet in diameter; the power is transmitted to five shafts 80 feet above by belts 173 feet in length, running at a speed of 7,200 feet per minute.

The dynamo room is directly over the shafting, from which all of the dynamos are belted through the floor. The dynamos are the United States system.

They have in service 325 city arc and 140 commercial arc lamps; also 1,500 incandescent lamps and two 10 horse-power motors. They have just placed one 85 horse-power generator and one 1,500 light Westinghouse alternating dynamo.

As a reserve power, they are putting in a 400 horse-power engine. The city lights are being furnished at 27 cents per light.

In addition to those I have mentioned, there are five incandescent plants and one arc isolated plant run by water power in Rochester, some 500 incandescent and 25 arc lamps, making a grand total of 1,991 arc and 16,640 incandescent. The population of Rochester is 135,000, making a very high average per capita.

All, I am sure, feel the very great necessity for a more comprehensive and uniform system of accounts.

A system that will show the exact cost per unit of their output.

A system that, being kept uniformly by all, will give managers an opportunity of comparison with each other.

This knowledge of cost per unit of output is particularly felt at this time, since nearly all central stations are in direct and active competition with other illuminating companies and with other means of supplying power.

At present no two keep their accounts alike, hence, comparison with each other is out of the question.

The principal function of accounting is to bring out the fact that the average cost of certain items of expense per unit of output in one station exceeds the average cost per unit of the same items of expense in another station, and the accuracy of these averages depends entirely on the uniformity of accounting. Great differences in these averages would prompt an inquiry as to the cause, and if the circumstances did not warrant higher averages, steps could be taken to

CAMDEN LIGHTING AND HEATING CO.

GENERAL STATEMENT OF EARNINGS AND EXPENSES FOR MONTH OF.....189....

EARNINGS					EXPENSES				
FROM	189....	189....	INCREASE	DECREASE	EXPENSES OF	189....	189....	INCREASE	DECREASE
Arc Lighting					Arc Lighting				
Incandescent Lighting					Incandescent Lighting				
Power—St. Cars					Power—St. Cars				
" Stationary					" Stationary				
Miscellaneous Sources									
Total					Total				
		Net					*Net*		

EARNINGS AND EXPENSES, SHOWING NET EARNINGS			
FROM ALL SOURCES	GROSS EARNINGS	EXPENSES	NET EARNINGS
Month of			
Same month last year			
Increase			
Decrease			
Jan. 1st to			
Same period last year			
Increase			
Decrease			

DR. BALANCE SHEET CR.	
To	*By*
Respectfully submitted,	.....*Secretary.*

Uniformity in Method of Keeping Central Station Accounts.

BY J. J. BURLEIGH, CAMDEN LIGHTING AND HEATING COMPANY.

The National Electric Light Association partially fills its mission by bringing together, twice a year, central station managers and others interested in the production of light and power, but notwithstanding the very valuable paper of Mr. A. R. Foote, read at the Niagara Falls meeting, and the papers of Messrs. Smith and DeCamp, read at the Kansas City meeting, absolutely nothing has been accomplished towards a uniform system of accounts or a classification of expenses.

CHARGEABLE TO	Arc Lighting	Incandescent Lighting	POWER St. Cars	POWER Stationary	TOTAL
Boilers, repairs of					
Belting, "					
Boiler House and Stock, repairs of					
Carbons					
Clerks					
Converters, repairs of					
Dynamos "					
Dynamo Attendants					
Enginemen and Firemen					
Engines, repairs of					
Fuel					
General Officers' Salaries					
Horses, Wagons and Harness					
Insurance					
Interest on Notes, Bonds and Mortgages					
Incidentals					
Instruments of all kinds					
Lamps, repairs of					
Lamp Supports and Fixtures					
Lamp Globes					
Lamps, Incandescent					
Linemen					
Labor at Stations					
Labor on Street Cars					
Loss and Damage					
Legal Expenses					
Meters, repairs of					
Motors "					
Oil					
Office expenses, repairs and furniture for					
Poles & Lines, maintenance & renewals of					
Right of way					
Station, repairs of					
Stationery and Printing					
Superintendent and Foremen					
Steam Piping, repairs of					
Shafting, "					
Taxes, City					
Taxes, State					
Tools, repairs and renewals					
Trimmers and Inspectors					
Water					
Waste					

CAMDEN LIGHTING AND HEATING CO.

STATEMENT OF EXPENSES FOR.....189

HEADS OF ACCOUNTS	Arc Lighting	Inc. Lighting	POWER St. Cars	POWER Stationary	TOTAL
Boilers, repairs of					
Belting, "					
Boiler House and Stack, repairs of					
Carbons					
Converters, repairs of					
Clerks					
Dynamo, repairs of					
Dynamo Attendants					
Enginemen and Firemen					
Engine, repairs of					
Fuel					
General Officers' Salaries					
Horses, Wagons and Harness					
Insurance					
Interest on Notes, Bonds and Mortgages					
Incidentals					
Instruments of all kinds					
Lamps, repairs of					
Lamp Supports and Fixtures					
Lamp Globes					
Lamps, Incandescent					
Linemen					
Loss and Damage					
Labor at Station					
Labor on Street Cars					
Legal Expenses					
Meters, repairs of					
Motors "					
Oil					
Office Expenses, repairs and furniture					
Poles and Lines, repairs and renewals					
Right of Way					
Station, repairs of and furniture for					
Stationery and Printing					
Superintendent and Foremen					
Steam Piping					
Shafting					
Taxes, City					
Taxes, State					
Tools, repairs and renewals					
Trimmers and Inspectors					
Water					
Waste					
Total Expenses for Month					

Total average arc lights, ... Total inc. output in ampere hours, ...
Total arc light hours, ... Total as shown by meters, ...
Total cost per arc light hour, ... Total loss, ...
Total cost per 100 ampere hours, ...
Total stat'y power output in watt hours, ...
Total as shown by meters, ...
Total loss, ...
Total cost per 1,000 watt hours, ...

REMARKS.

.....

reduce the cost of these particular items To make these comparisons of any value to those desiring to make use of them, a uniform classification of accounts should be adopted, and to insure accuracy, the different items of expense, chargeable to the different accounts, should be specified.

The operating accounts proper embrace the current working expenses and the cost of keeping in good order the original plant.

The company with which I am connected have classified their accounts.

All expenses that are naturally or entirely charged to either arc lighting, incandescent lighting or power, are entered in their respective columns; expenses that are not entirely charged to any one service are apportioned on horse-power output basis, making the division as between arc, incandescent or power, in the proportion which the horse-power used for each bears to the total horse-power output.

For the proper division of those accounts not chargeable entirely to any one of the principal departments; for example, the total output of the station being 1,000 horse-power, the company operating 500 arc lights, 2,500 incandescent lights and 250 horse-power for power, the division of a bill for boiler repairs, engine repairs, fuel and similar devisable accounts, would be ¼ arc lighting, ¼ incandescent lighting, ½ power.

The division to be accurately determined each month.

No intelligent economy can be practised without a thorough knowledge of the cost in the past and a comparison of the same with the present outlay. Constant comparison of accounts tend to economy. The experience of other companies is a good guide and would be found of great utility.

I would like to urge upon the convention the importance of the adoption of some uniform classification of expenses that they can recommend to central station managers for their adoption.

It does not follow that central station managers are to expose their books in detail, but to so prepare their accounts that they can give the secretary of the National Association replies to such questions of cost per unit as would be proper to exhibit to the other members.

Such statistics would be of the greatest interest and value; indeed, it would be of more value than all the other papers combined.

I have a station producing arc and incandescent light and power, earning a moderate dividend for its shareholders, but I have nothing to guide me as to how my expenses per unit compares with other central stations. I would give much for such information.

Therefore, I conclude that this is one of the most important subjects that can engage the attention of the Association.

CAMDEN LIGHTING AND HEATING CO.

COMPARATIVE STATEMENT OF EXPENSES.

HEADS OF ACCOUNTS	MONTH OF 189..	MONTH OF 189..	INCREASE	DECREASE
Boilers, repairs of				
Belting, "				
Boiler House and Stack, repairs of				
Carbons				
Converters, repairs of				
Clerks				
Dynamo, repairs of				
Dynamo Attendants				
Enginemen and Firemen				
Engine, repairs of				
Fuel				
General Officers' Salaries				
Horses, Wagons and Harness				
Insurance				
Interest on Notes, Bonds and Mortgages				
Incidentals				
Instruments of all kinds				
Lamps, repairs of				
Lamp Supports and Fixtures				
Lamp Globes				
Lamps, Incandescent				
Linemen				
Loss and Damage				
Labor at Station				
Labor on Street Cars				
Legal Expenses				
Meters, repairs of				
Motors, "				
Oil				
Office Expenses, repairs and furniture				
Poles and Lines, repairs and renewals				
Right of Way				
Station, repairs of and furniture for				
Stationery and Printing				
Superintendent and Foremen				
Steam Piping				
Shafting				
Taxes, City				
Taxes, State				
Tools, repairs and renewals				
Trimmers and Inspectors				
Water				
Waste				
Total Expenses for Month				

COMPARATIVE STATEMENT OF OUTPUT.

REMARKS.

Secretary.

Some Details of the Care and Management of an Arc Lighting System, as Practiced in the "Municipal," of St. Louis.

BY JAMES I. AYER, BEFORE THE NATIONAL ELECTRIC LIGHT CONVENTION.

As central station men, it seems to me that we should demand of each other as much knowledge of the practice and experience as is practicable to give. In fact, if this Association is to be useful, our meetings should be largely "experience meetings," and the practical experience of those engaged in the development of the lighting and kindred industries, if given liberally at each meeting, would be followed closely by those interested in the production of electrical apparatus and supplies, and would do much to advance the business and improve appliances. Believing that we are here, as central station managers, for mutual improvement and for the free interchange of ideas and experience, I have presumed to present you with a limited, though doubtless dry, outline of the practice which obtains in the central station under the writer's charge.

The station, as designed, has a working capacity of 6,000 arc lights, and is now operating daily 3,500, and about 200 constant current motors; 2,000 of these lights are distributed over an area of 60 square miles, suspended between and from poles 50 and 65 feet in length, at a height of from 35 to 50 feet above the roadway, an average distance apart of about 900 feet, and used for street lighting. The motors and about 1,500 lamps are operated for the usual varied service of private consumers; 69 circuits supply the lamps and motors, containing about 1,200 miles of wire and supported on 12,000 poles.

For generating the current, we have six 600 horse-power Corliss engines, which drive 300 feet of shafting, from which are driven sixty-five 60 light, and twelve 80 light, 2,000 candle-power arc dynamos. The arrangement of the dynamos is such that we have ample room for the care of 85 machines on a floor space of about 100x45 feet, and are able to operate a large number of dynamos with a very limited amount of help. Four boys and one young man of very limited experience care for all the machines during the night, in an entirely satisfactory manner; while a suitable man, with three assistants, give the necessary care to the dynamos during the day.

Thirty-one trimmers, with horses and carts, travel about 500 miles a day to renew the carbons in the street lamps. The average number of lamps to each of these trimmers is 68. Sixteen trimmers care for the 1,500 commercial lamps. Five inspectors, or troublemen, with carts and horses, care for the lines night and day, answer fire alarms, locate faults and correct minor troubles on the lines. Two day and two night inspectors care for the commercial arc and 2,500 incandescent lamps. A stable of 20 horses, in addition to the 40 horses owned by the trimmers and inspectors, is required. The maintenance of 60 vehicles justifies a blacksmith and wagon shop, which, with the stable, require the service of eight men. Two men care for the shafting and three engineers and four oilers for the engine room. In the boiler house, where there are nineteen 300 horse-power boilers, there are two pump men, with two assistants, 12 stokers, one boiler cleaner and six coal shovelers. These, together with an average force of 35 line and ground men, foremen, chief trimmer, chief inspector, superintendent of lines, storekeeper, repair shop employés, carpenters, clerks, etc., constitute a force of about 170 men. A very large per cent. of these men are called upon to perform duties that are simple, yet, because of their extreme newness, are not thoroughly comprehended by them. To get the best results, each man requires clearly written rules, as few of them as possible, and their rigid enforcement. In all practice this is the wise way to put it; but it is absolutely necessary that it be so with a large force, where many of the men do their work independently, and free from the constant supervision of a foreman.

In the room used as an office at the station by the inspectors and foremen are city maps, mounted on boards, where the locations of the lamps are indicated by tacks and the circuits by strings. For the central part of the city, where there are many circuits on the same line of poles, each circuit is shown on a separate map of that section. A number of printed slips, which represent a pole with cross-arms, indicate the location of the wires on the poles on the different streets traversed by the different circuits. Any change of circuits is noted on a separate blank when the work is ordered, and when completed the maps are corrected to correspond. It takes but a few days for a man to become quite familiar with the circuits, by keeping them so conspicuously placed. In large stations this method of indicating circuits is almost indispensable, and will prove of great value if used in smaller ones.

For testing purposes we have a portable tachometer for indicating speed, two Thomson indicators for the engines, a recording steam gauge, two standard ammeters and a voltmeter reading to 5,000 volts for the dynamo room; on each circuit a spring socket for attaching ammeters and a current indicator for indicating the direction the current is flowing through the circuit; near the lightning arresters on the upper floor, a switchboard specially arranged for testing only; a wheatstone bridge, magneto bells, etc. The engines are indicated once each day.

Evaporation boiler tests are made every month to see that the quality of coal is maintained at the standard. All the circuits are tested four times each day. All live circuits during the day are tested for grounds, and all others for apparent open circuits as well. In addition to this, all circuits are tested while alive by taking volt and ammeter readings simultaneously. The number of miles of wire and number of lamps being known, any material increase in the energy consumed gives evidence of a fault not always easily discovered by other methods. In testing for grounds on circuits not alive, a strong magneto bell is used. For all other testing a battery current of from 30 to 50 volts is used, and the circuit is required to pass at least one ampere to operate an ordinary call bell. When this bell is placed in series with a circuit which has more resistance than will pass this current at the pressure, the circuit is at once inspected and the fault located. In locating the trouble, one side of the bell circuit is connected to the line and the other to earth. The inspector or trouble man carries a similar bell with him, which he connects in series with the earth and line at various points, until the fault is located. The value of circuit testing with low voltage is keenly appreciated by those who have practiced it. When the circuits are alive, ammeter readings are recorded every two hours, and all readings are from the same instruments. These instruments are arranged so as to be read singly or in series, and one is used to check on the other. The value of first-class instruments in plants of any size cannot be over-estimated, and should be in daily use in all stations, rather than the makeshifts generally supplied.

The stopping and starting of engines and boilers, pumps, dynamos, circuits, etc., are all recorded on reports made by those in charge of the different departments. Each inspector, trimmer, line foreman, storekeeper, and all heads of departments make daily reports of work done, and time and material used by them. Each trimmer is charged with a certain number of demerits for each fault on his route, such as defective or dirty lamps, broken or dirty globes, carbons used in excess of the required number, etc., and each month prizes are awarded to those having the best records.

The advantage of using vehicles for trimmers for all street lighting work is being recognized. Provide a man with proper appliances and your service will improve. He cannot carry all that he should and walk long distances, nor will he take the same care when he is worn out with tramping that he otherwise would. We find it desirable for the trimmer to own and care for his own horse, while the company provides a suitable vehicle and harness, which he turns into the stable once a week for inspection, cleaning and repairs, when needed.

We select from our line men those whom we class as inspectors or trouble men, who are equipped with a light-running cart, with a suitable place for the storage of all tools necessary to use in an emergency. In addition to the special duty required of them during storms or at fires, these men correct all minor troubles reported to the office from various sources. During the first year's operations the average time lost, due to open circuits at night—that is, the average time lost from the time the circuit was opened until it was closed and the lights restored—was an hour and five minutes, notwithstanding that all circuits are more than 10 miles in length. When these troubles occur, it is almost always during a storm, but the conveyances with which they are provided and their thorough knowledge of the circuits enable them to become very expert in locating and correcting troubles. During the past year nearly 15 per cent. of all the calls answered by our trouble men were to correct troubles on the lines of other companies. Because we have wires all over the city, the police, and the public generally, think that all the wires belong to us, and, when they discover any trouble with them, are very apt to report the same by telephone to our station. During the entire 24 hours there is always one man on duty, ready to answer just such calls and correct the troubles.

All arc lamps before leaving the station are placed in a test rack, where they are supplied with a current maintained absolutely constant. Voltmeter readings are noted soon after the lamps have been lighted, when the carbons are about half consumed, and also when they are burned quite short. During the early part of the burning the lamp is adjusted so that the readings, taken at three different points, give an average reading of 46 volts. In case of double lamps this work is carried out on both rods. This extreme care in regard to adjustment we regard as absolutely necessary. If a lamp is permitted to consume its carbons any fault which would not be discovered with a brief test is quite likely to develop. To determine the length of arc by the current and voltage is more likely to result in uniform lamps than when tested by the eye. With 10 lamps, adjusted to burn at an average of 46 volts, with 9.5 amperes, the average number of watts per lamp was 436. Without changing the adjustment of the lamps the current was increased to 9.8 amperes, and there was an average consumption of 524 watts per lamp, an increase of 20 per cent. of energy; and by increasing the current to 10 amperes the average number of watts per lamp was 550, the average voltage 58, the increase above normal being 33 per cent. That means 33 per cent. more coal, 33 per cent. more work at your dy-

namo, 33 per cent. less capacity in your dynamo, and probably 33 per cent. less life in your armature. One is apt to think that the difference between 8.5 and 10 amperes, when supplied to the lamp, is only a difference of 5 or 10 per cent., which is not very serious. This would be true if the lamp were adjusted each time for the ampere current it was to be operated with. To those who have not made this experiment, perhaps, a portion of the mystery as to where the coal goes will be cleared up. By using the ammeter and voltmeter for adjusting the lamps, and then seeing that the circuits are provided with the same ampere current indicated by the same ammeter, one will be apt to bring about like conditions in all lamps; at least they are more likely to be uniform than if independent ammeters are used on each circuit. By reference to this statement relative to the amount of energy consumed by change of current, it will be easy to see how expensive one or two low lamps would be on a circuit where the operator, to correct the trouble, supplies them with current enough to make them bright. Of course, it is understood that better service as well is obtained by operating the circuits with no more current than that for which the lamps are adjusted. In this connection, I believe it is proper to again call attention to the well-worn subject of connections. A great deal of time and trouble is spent in soldering joints, and when the lines are led to the lamp they are apt to be poked into the binding posts, held with set screws indifferently tightened, and between these binding posts and the lamp connections proper there are perhaps three or four, if not more, indifferent contacts, all of which look very well in the factory but are very bad after a few months' service. Hanger-boards should be used which have the line wire soldered to connections which cannot get loose. In our practice we accomplish this by using about 18 inches of flexible insulated cable, which is soldered to the hanger-board binding posts at the station (cut-out boxes are treated in the same manner), leaving the lineman nothing but an ordinary line joint to make, which can be easily done outside. Where lamps are suspended from the hanger-boards by the hooks which conduct the current we always insist on some character of second connection being made to the lamp besides this. A simple way to do this is to take some small wire and tie the hook to the loop, in much the same manner as you would with a piece of twine. We have no screw connections anywhere in our circuits, and with a little ingenuity and care they can be avoided always in arc-lighting circuits. By the use of a special socket in each circuit for connecting an ammeter we are able to take the readings with volt and ammeter and get a correct indication of the actual consumption of energy on a circuit while in operation. With the data relative to the number of lamps in service and the number of miles and size of wire, we are able to discover any excessive consumption of energy and prevent the development of a series of little faults, which, in a short time, grow to be very serious ones, if permitted to continue. Usually these readings are taken on each circuit three times a week, and during the time these observations are made indicator cards are taken from the engines. From these two sources we get the actual consumption of electrical energy per circuit and per engine. We also get the indicated horse-power. From a set of 11 observations taken from July 30 to August 28, at various hours during the night run, the station shows an efficiency, between indicated horse-power and electrical horse-power at dynamo terminals of 74.9 per cent., ranging from 70.3 per cent., the lowest, to 77.5 per cent., the highest efficiency shown. The circuit readings indicate an average consumption of energy per lamp of about six-tenths of an electrical horse-power. The average indicated horse-power is about eight-tenths per lamp. A good condition of the circuits is maintained constantly, because any neglect in any department is quickly shown by the data obtained from our records. Some months ago, when press of business caused the measurement of circuits to be neglected for a few weeks, the writer discovered an increase of over ten per cent. in the consumption of fuel, when there should have been a slight decrease. An investigation showed that an accident to an ammeter had caused a false reading, which increased the cost of fuel alone about $16 a day. The difference in the appearance of the lamps was not such as to call forth special comments then by those interested, yet, when the fault was discovered, it was remembered that some seemed to have been burning high for a week or two. On suburban circuits, on long loops, it is our practice to place cut-out boxes on the pole where the line branches. This saves a great deal of time in locating troubles; but, let me add, that unless a thoroughly watertight and substantial cut-out is used, it will prove more of an annoyance than an advantage. A log of each circuit and dynamo, as well as of engines and boilers, is a very satisfactory and desirable part of the records, and will frequently assist materially in locating troubles and saving expense.

Throughout the country it is almost the universal practice to wire for arc lights without cost to the customer. There is no valid reason for this custom, and for more than a year it has been our custom to charge for cost of labor, with the result of reducing expenses more than $600 per month. In every case where lamps are discontinued in the Spring we require a contract for Fall and Winter service, else the wires are removed when the lamp is taken down. We invariably cut down the line between the house and pole where the service is discontinued for the season, though it is to be renewed later. To induce annual contracts, a rebate of five per cent. is given at the expiration of the year, and is found to work to advantage.

There are very many details of construction, as well as of office work, which could be referred to, if it were not that this paper is now too long; but I will be glad to furnish a copy of "general instructions to employés," used in the government of this plant, which refer to and bring out some points of management which are not mentioned here, to those who care for them.

Different Forms of Carbons Used in Arc Lighting.

BY W. C. WARNER.

In the period just proceeding the introduction of the arc electric lighting commercially, experimenters and inventors had brought forward numerous plans, ideas and theories regarding the size, form and manner of using carbons, and in view of the fact that no reasonably cheap method of generating the electric current then existed, a surprising amount of attention was given to the subject, and the developments of the art, shown by many publications, form no small part of our history of arc lighting.

It is not my purpose to dwell at length upon the history of carbons generally, but rather to touch lightly on some of the more notable forms known at the time of which I am speaking, and then to pass on to a consideration of the utility and practical results obtained with the different forms of carbons in use at the present time, paying special attention to the matter of form and size as affecting the results.

The form of a cylinder or pencil, it is noteworthy, was that used by Sir Humphrey Davy, in his earliest experiments, and he even devised special holders or claims to retain the carbon pencils in all alignment and facilitate their adjustment with a view of maintaining a constant and steady light.

Archereau subsequently adopted the pencil form of carbon and used it in his lamp now so justly considered as the first practical arc lamp; it does not appear, however, that he turned his attention particularly to the matter of form.

Wright and others stand on record as experimenters with carbon disks brought edge to edge and made to rotate as they were consumed, and the combination of a disk placed on edge above a vertical pencil of carbon was also tried at this early date.

Wallace and Farmer made use of broad, flat plates of carbon, placed in a vertical plane, one above the other, the arc forming between the edges as they were drawn apart and shifting back and forth from one end of the plates to the other. Another inventor, at about this same date, placed flat plates of carbon side by side with the arc forming at the upper edges of the plates and an intervening insulation of some refractory material, the arc forming at the upper edges of the plates and gradually consuming them.

Jablochoff, in 1876, introduced his well known electric candle, a form of arc lamp in which cylindrical carbons are employed, placed in a vertical position and held separated by a thin filling of refractory insulating material.

Now, when we look back at the work of these early inventors and consider what special object they had in mind in making their experiments, it is at once apparent that it was continuity of action, and it stands on record that they met with fair success, so far as the feature is concerned, some of the lamps being capable of 20 hours burning without attention.

In 1874 Mathias Day produced an arc lamp in which two cylindrical pencils were placed in the upper holders and two in the lower holders, the upper ones occupying a plane with the lower and directly over them. Here the avowed object of the invention was to secure long-continued operation of the light without requiring attention, and it is certain that he accomplished it in a very creditable and ingenious manner.

Coming now to the time of the commercial birth of arc electric lighting, we find Jablochoff in the lead, closely followed by Brush and Weston, each making use of the cylindrical form of carbon pencil and turning their attention most assiduously to the feature of continuity of operation, the first move being an increase of the length of the pencils. Carré, a French manufacturer, at this time became prominent as a maker of carbons, and succeeded in producing pencils about $\frac{7}{16}$ inches diameter, and 32 inches in length, and it was thought by the use of lamps of suitable length these long carbon pencils could be advantageously used when long-continued burning was a necessity, but owing to the difficulties encountered in the manufacture and also trouble in maintaining proper alignment for the carbons, a length of 22 inches was soon settled upon as most practicable and convenient.

As the business increased and the demands became better understood, the inventors again essayed to solve the problem of continuity of action, but, in many cases such attempts were but returns to old forms and methods, and did not result in any practical advance.

Various forms of double carbon lamps were introduced, and, for a time, these were thought to be the only practical and commercially successful way out of the difficulty, but more recent developments have shown a far simpler and better way, and one furthermore, that cannot fail to impress the practical electrical engineer. I refer to the simple expedient of using a carbon pencil of $\frac{5}{8}$ inch diameter 14 inches in length in an ordinary single carbon lamp. It is true that this is not new, and that carbon pencils of such size, or even greater, were tried long ago; nevertheless, the introduction of carbons of this size and form has a very great bearing on the commercial side of the situation, but, before going into that matter, I wish to say a few words regarding the lighting efficiency of $\frac{5}{8}$ inch carbons.

Having noticed that the question had been raised as to whether these carbons would give as much light for a given expenditure of electrical energy as would those of one inch diameter, I tried the following experiments:

Two single lamps were connected in series in an arc circuit, one being supplied with $\frac{5}{8}$ inch carbons 14 inches in length, the other with $\frac{1}{2}$ inch carbons 12 inches in length. Around each lamp was branched a voltmeter indicating the voltage. The lamps were then adjusted until they had the same voltage, and as current was, of necessity, the same in each, it was a safe conclusion that equal amounts of energy were being supplied. Photometric comparison of the two lights was then made at the horizontal and at many different angles above and below, with the result that no perceptible difference could be found in the power of the lights. During the tests the current was maintained as constant as practicable and care was taken to base the comparison on an average deduced from a large number of readings.

Now, while this matter of lighting efficiency is one that concerns the people operating electric plants, it does not interest them to the extent that other features upon which I have yet to touch, may, as I happen to know that the management of lighting stations look long and lovingly on any plan that seems to give good promise of reducing running expenses. To begin with, there is the difference in first cost between a single and a double carbon lamp, and the difference in the expense for repairs and attendance, these items varying, of course, with the different lighting system. Still another important saving is in the cost of carbons, the cost for a given number of hours run being fully 30 per cent. greater with $\frac{1}{2}$ inch than with $\frac{5}{8}$ inch carbons. There is the further important saving in the breakage of globes, which often is caused by the sudden shifting of the arc in the double carbon lamp. Twin carbons, consisting of two cylindrical pencils placed parallel and in close juxtaposition to each other, and connected by a web throughout their entire length, have of late been introduced, and when in use the arc alternates between the different pencils comprising the upper and lower twin carbons. A test of these carbons, made principally with a view of determining the life and lighting quality, gave unsatisfactory results in the following particulars. It was observed that the duration of a burning for a given weight of material was not near equal to that which could be obtained with the same amount of material in a single cylindrical pencil. This I attribute to the more rapid disintegration of the turn carbon, resulting from the very frequent heating and cooling of each member; indeed, this is found to be true of two carbons where arranged as in the Day lamp, or so that the arc alternates frequently between the different sets, and there is quite a noticeable difference in consumption of carbon for a given duration of lighting, as compared with an ordinary single carbon of the same diameter burning without interruption.

Another undesirable feature of twin carbons is the shadow cast by the non-burning members, which, while it may not be disagreeably noticeable when the lamp is provided with an open globe, most certainly operates to reduce the total output of light.

It may be argued that the main item of expense in the manufacture of carbons does not lie in the material, and the fact that $\frac{5}{8}$ inch carbons cost so little more than $\frac{1}{2}$ inch would bear out such a position, and I have merely mentioned the fact of the rapid disintegration and burning away of the turn carbons by way of explanation.

The Latest Figures.

Whipple's Reports, for September, 1891, furnishes the following information:

CENTRAL STATION COMPANIES.	
Stations in United States	1,786
" Canada	143
" Cuba	1
" Mexico	10
Total	1,940

STREET RAILWAY COMPANIES.	
Companies in United States	983
" Canada	26
Total	1,009
Electric Roads in Operation and under Contract in United States	336
Electric Roads in Operation and under Contract in Canada	8
Total	344
Cable Roads in the United States	53

PERSONAL.

Prof. Edward Weston, of Newark, N. J., is convalescing from a rather serious illness of several weeks' duration.

M. Paul Le Brun-Aragon, a noted Parisian dealer in platinum, was recently the guest of Mr. C. O. Baker, Jr., at the New York Electric Club.

W. B. Pearson, of Chicago, agent for the Ball & Wood Company, was a recent New York visitor. He is nearly as large now as his old friend Chas. D. Shain, of the Edison General Electric Company.

Mr. M. C. Sullivan, who has lately left the ranks of the journalists to engage in business for himself, was at Montreal, renewing old friendships and receiving the well-wishes of his many friends in the electrical field. Mr. Sullivan is one of the enterprising young men in this business, and the line which he is to engage in is an entirely new and novel branch of electrical manufacture. Although Mr. Sullivan is no longer one of the newspaper men, his many old friends and associates wish him every possible measure of success.

"Engineers' Manual and Directory of Steam Specialties," has been received from The J. N. Mills Publishing Company, New York. This little book contains valuable hints and rules for the management and care of steam boilers, besides being a useful directory.